Journal of the Society of Arts.

FRIDAY, JULY 24, 1868.

Announcements by the Council.

HARVESTING CORN IN WET WEATHER.

The Essay by Mr. W. A. Gibbs, of Gillwell-park, Sewardstone, Essex, for which the Gold Medal of the Society and a prize of Fifty Guineas were awarded, will shortly be published by Messrs. Bell and Daldy, York-street, Covent-garden, publishers to the Society of Arts; price one shilling, illustrated by woodcuts.

SUBSCRIPTIONS.

The Midsummer subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to Mr. Samuel Thomas Davenport, Financial Officer.

Proceedings of the Society.

COMMITTEE ON TECHNICAL EDUCATION.

A meeting of this Committee was held on Tuesday, the 21st inst., WILLIAM HAWES, Esq., in the chair, to receive the report of the Sub-Committee appointed on the 26th February last (see *Journal*, p. 275), "with power to add to their number."

The following is a list of the Sub-Committee, as finally constituted :—

T. D. Acland, M.P.	Professor W. A. Miller, F.R.S.
General Sir W. Codrington, G.C.B.	Professor W. Pole, F.R.S.
R. Coningsby.	Dr. D. S. Price.
T. Connolly.	J. Scott Russell, F.R.S.
Sir Daniel Cooper, Bart.	Rear-Admiral Ryder.
Dr. Frankland, F.R.S.	B. Samuelson, M.P.
Thos. Gray.	J. P. Seddon (Sec. R.I.B.A.)
William Hawes.	R. P. Spiers (Pres. Architectural Association).
G. W. Hemans.	Dr. Storrar.
Hon. Auberon Herbert.	Capt. Toynbee.
Professor Hirst, F.R.S.	Professor Voelcker.
Professor Huxley, F.R.S.	Prof. Williamson, F.R.S.
Professor Fleeming Jenkin, F.R.S.	The Archbishop of York.
Professor Leone Levi.	

This Sub-Committee, having held twenty-six meetings, agreed to the following

REPORT.

The Sub-Committee, appointed on the 26th February. in the exercise of the power given to them to add to their number, have obtained the active and valuable co-operation of the following gentlemen:—Professor Hirst, F.R.S., Professor Williamson, F.R.S., Dr. Frankland, F.R.S., Samuel Redgrave, Dr. David S. Price, Sir Daniel Cooper, Bart., T. D. Acland, M.P., General Sir W. Codrington, G.C.B., Captain Toynbee, Thomas Gray, Professor W. A. Miller, F.R.S., Dr. Voelcker, J. P. Seldon, of the Royal Institute of British Architects, and R. Phené Spiers, President of the Architectural Association. This enlarged Sub-Committee has now the honour to present the following report:—

It has been thought unnecessary to enter into the questions of how far better technical instruction is desirable, how far this country may be behind other nations in this respect, or what degree of injury the arts. commerce, or manufactures of this country have sustained from the present defective state of education. The Committee have assumed that the country is unanimous in desiring improvement, and have confined their attention to the consideration of practical measures intended to effect that improvement.

The technical education of workmen must necessarily be considered apart from that of masters, managers, or professional men. The Sub-Committee have devoted their chief attention to the higher grades of instruction, believing that our defects are far more due to the ignorance of those who direct works than to imperfect technical education, want of skill, or incapacity in those who execute them.

At the outset of their inquiry the Sub-Committee felt some embarrassment as to the meaning of the words "technical education." Taken in their most general sense, these words include all manner of instruction required by the workman for his craft, by the manufacturer for his business, by the professional man for his practice. Technical education in this sense is synonymous with the whole education of the country, so far as that education is not directed to "culture;" and if, as we believe, culture be useful, technical education in this broad sense must be considered as embracing both education commonly so called, and in addition the special training received in the workshop, the factory, the office, and in all other places where young men learn to practise the craft, art, or profession by which they gain their bread.

The Sub-Committee did not understand that they were called upon to grapple with so gigantic a problem as a scheme for the general education of the country. Looking at the discussions which gave rise to their appointment, they believed that the complaints made of defective technical education arose from the belief (whether correct or not) that for the members of certain professions, arts, and handicrafts requiring a knowledge of mathematics and the natural sciences, no sufficient education was to be obtained in England. Although the system of apprenticeships may call for special inquiry, and, possibly, for legislation, your Committee, in order to restrict its inquiry within reasonable limits, and to carry out the views expressed by the general Committee, resolved that—"*For the purposes of discussion, technical education should be deemed to exclude the manual instruction in Arts and Manufactures which is given in the workshop.*"

When dealing with the higher grades of education, the Sub-Committee felt that on similar grounds they were precluded from the consideration of the practical training given to business and professional men, as clerks or pupils. The form of this practical training (which the Sub-Committee regard as essential) is determined in each case by special circumstances, over which no government or committee have any control; and it was therefore necessary to confine the investigation to the best form of preparation for this practical pupilage.

The consideration of the education of the members of the clerical, legal, and medical professions was also set on one side. The Sub-Committee were thus led to use the term "technical education," as meaning "*general instruction in those sciences, the principles of which are applicable to various employments of life,*" and further to consider only the following employments, so far as the higher grades of education were concerned:—

The Civil Engineer.
The Mechanical Engineer.
The Architect.
The Chemical Manufacturer.
The Agriculturist.
The Metallurgist.
The Miner.
The Merchant.
The Officers of the Army and Navy.
" " " Mercantile Marine.

As regards the higher education, which will be first considered, two distinct schemes were discussed. Firstly, technical education might be given in special schools. Secondly, in institutions devoted to the general purposes of education. Special colleges for the education of the members of all the above professions are to be found abroad. The polytechnic schools of Germany and Switzerland were especially urged upon the Committee as worthy of imitation. Sufficient evidence exists that in those institutions good scientific instruction is combined with practical training to an extent which Englishmen can hardly credit, unaccustomed as they are to see practical work learned otherwise than by practice. While, however, your Sub-Committee recognise the great merits of these institutions, they do not recommend them for imitation, but, on the contrary, resolved—"*That technical instruction, as defined above, should not as a rule be given in separate professional institutions, but in institutions established for general education.*"

The reasons for this conclusion may briefly be stated as follows:—

Where training in polytechnic schools is adopted, the system of pupilage does not obtain; the number of years at the disposal of young men for their professional training does not allow of the combination of the higher school teaching with the teaching by pupilage, and of the two the latter is considered preferable. It would also be almost impossible, even if it were desirable, to substitute the foreign for the English system, and there is certainly no such clear advantage gained abroad as would justify the attempt. As a minor reason, may be mentioned the great difficulty in obtaining duly qualified professors. Very few of the foreign institutions are self-supporting, and in this country, competing against the pupilage system, they would need to be supported by very large Government grants, such as should not be given to secure a doubtful advantage. New special schools of the highest grade would also, in many places, compete with existing universities and colleges, and it would be improper to support by Government aid the special school, giving the narrower course of instruction, rather than the university or college, giving the more general culture and more purely scientific training.

The foreign polytechnic schools include a large number of classes for teaching pure science; these could be as well held, if not better, in universities or institutions giving a general education, and it is this part of the training which the Sub-Committee are chiefly desirous of recommending for imitation, not the practical portion, which is better given by the pupilage system. Again, our universities and colleges can readily adopt some courses on the applications of science, and thus provide such special teaching as may with advantage be given in class-rooms at much less expense than would be entailed by the institution of special schools. On these grounds the Committee decided against the institution of special professional schools as a rule.

None of the objections to these schools apply to special courses of study intended to fit students for a subsequent pupilage. The Committee, therefore, for the guidance of parents, students, and colleges, obtained reports on special courses adapted for each business from those members of the Committee who were specially conversant with each subject. The reports of these gentlemen are appended, and contain many valuable practical suggestions, but they rest solely on the authority of the gentlemen whose names are attached to them, and have not been adopted by the Committee. The uniformity as to certain subjects suggested is remarkable. Ten reports were received: of these all include mathematics, nine physics, nine chemistry, nine mechanical drawing. When these, which may truly be termed the mother sciences, have been stated, the other subjects appear in far smaller proportions. Three schemes include mineralogy, two geology, five applied mechanics under various titles.

With the exception of the reports presented by one gentleman, and the report on a mercantile education, all leave the special applications of science to the particular profession or business for the last year in the course; and although in this last year there was a clear concurrence in the recommendation of some special studies, there is a still more marked unanimity in recommending the study of pure science as the best ground-work for all technical education. The special applications of each science may be learnt in practice if a sound education in scientific principles has been received in early life. Without this sound elementary training the teaching of applied science at the best can only mean dogmatic instruction in rules which are not understood, and is liable to degenerate into mere quackery or child's play.

When the pupilage system takes the place of the foreign polytechnic school, and when it is understood that the best preparation for pupilage is instruction in pure science—it becomes clear that the colleges preparing students to become pupils must be institutions left by students at about the age of 18, and that these institutions will correspond far more nearly to the gymnasia and *lycées* of the Continent than to the universities or polytechnic schools. What is required is that students should enter on their pupilage as well instructed as foreign students enter the special schools of the Continent. This can be effected by existing colleges, if these institutions are willing to organize special courses of study, and found new chairs for professors of certain special applications of science. What those chairs should be may be gathered from the courses recommended in the appendix.

The existing colleges are, however, too few and too widely scattered to educate more than a small proportion of those who ought to receive a scientific education preparatory to technical pursuits. New colleges are therefore required; colleges of a type analogous to Owens College, and schools which would either prepare students for these colleges, or be analogous in their highest forms to those institutions. The class of schools required does not at present exist in England, though perhaps the modern department at Cheltenham nearly approaches to what is needed. Schools are wanted in which natural science should form the backbone, as it were, of the whole system of teaching, as classics may now be said to form the backbone of the teaching at Harrow or Rugby. Science in these new schools should be taught as a means of culture or mental discipline; and science here means mathematics, mechanics, chemistry, and physics. The study of languages, dead or living, should not be excluded from these schools, nor should the study of the natural sciences be excluded from the classical schools, but the two classes of schools, classical and scientific, should stand on one level, in a healthy antagonism, such as now exists between Oxford and Cambridge. Care should be taken that in the matter of buildings, endowments, and the salaries of professors, the new science schools should be on a footing of complete equality with the old classical schools; unless this be done, a certain stigma, involving less social consideration, and a lower standard in most respects, is certain to fall on the science schools, and this will result in filling those schools with outcasts from the more highly considered classical schools and with boys of a lower social standing, a result now to be observed in the *real schulen* of Germany, and in the students following the "special" courses of the French *lycées*. With the object of putting science on its true level, the Universities of Oxford and Cambridge should endeavour to attract the students

from science schools by offering them equal advantages, as to degrees, scholarships, and fellowships, as are now enjoyed by students of mathematics and classics. The standard in science schools will not be so high as it ought to be, if they are merely used to train lads intending to enter professions or trades on quitting these schools, leaving the preparation for our great universities to the classical schools. These considerations led the Sub-Committee to resolve:—"*That, with a view to the development of a system of scientific education, it is desirable that schools be established having for their main object the teaching of science as a mental discipline.*" *These science schools should prepare some youths for the higher courses of a college, and other less ambitious pupils for their professional pupilage.*

How are these science schools to be provided? The answer to this question is to be found in the report of the Schools Inquiry Commission.

The Commission recommend that the funds arising from existing endowments for educational purposes should be dealt with by Parliament; not only existing endowments for education, but those for other purposes, which appear useless, mischievous, or obsolete. They further recommend that every town with more than 20,000 inhabitants should be allowed to levy a rate for building and keeping in repair a school of the first grade. Here, then, are the requisite funds for our new science schools.

The Commission report that three grades of schools are wanted—those of the first or highest grade, intended for those who propose to continue schoolwork to the age of 18 or 19. These are the schools which would prepare our professional or business pupils, as well as those who intend to prosecute their studies at the universities or higher colleges. The Commission further report that "it would seem expedient, provided the district appeared to desire it, that some (of these schools of the first grade) should be semi-classical, and replace the study of Greek by more instruction in modern languages, in mathematics, and in natural science. There are boys whom their parents wish to keep at school till 18 or past, but who are not intended for the University, and who need more of these three last-named subjects than a classical school can easily give. For such boys all the lately founded schools have provided modern departments; but in all probability it would be still better that such boys should be taught in schools devoted to this object."

Your Sub-Committee concur in this recommendation and in these opinions, but they would call these schools science schools not semi-classical schools, a name which suggests mere imperfection; and they would expect these schools in time to prepare as many youths for the university as their classical rivals.

Coming to the machinery by which the new schools would be instituted and managed, the Commission recommend that each school shall be immediately under a separate governing body; that groups of schools shall be under a provincial authority, while the whole shall be under one central authority. They recommend that the central authority should be the present Charity Commission, with new members, and presided over by a president, who might be a minister of education. This body would examine schemes for the resettlement of educational trusts and submit them to Parliament, appoint inspectors, audit accounts, etc. The provincial authorities might be local boards, each containing one official district commissioner for each of the registrar-general's divisions, paid by Government, and assisted by six unpaid commissioners. Or these boards might be more popular bodies if it should appear that the country town or district desired to manage its own schools. The functions of the provincial board would be to prepare schemes for the management of all schools in their district, and submit these schemes to the central authority. The provincial board would, therefore, prepare schemes for the establishment of the proposed new science schools, that is to say, they would report in each district whether in that district science schools or classical schools were most required, and on what scale, as to endowment and buildings, these new schools and old converted schools should be established.

The immediate management of each school would be carried on by a board of governors; and the commission show how present trustees, aided by new members, elected by householders or appointed by a town council, would form a new board of governors suited for day-schools, while for boarding schools a similar governing board might be formed out of the old trustees and new governors named by the provincial boards.

The adoption of some such scheme as this would provide the country with true public schools, without inflicting upon us a new huge government department with stereotyped courses of study, and with history, classics, science, all cut out to a regulation pattern. Without accepting the scheme of the commission in all its details, your Sub-Committee, seeing that if vigorously acted upon it would provide the new science schools which are required, resolved:—"*That the subject of secondary instruction having been reported upon ably and deliberately by the Schools Inquiry Commission, the Committee do not feel it necessary to enter into the details of this subject, while they desire emphatically to express their opinion of the necessity for the introduction of scientific teaching in all secondary schools.*" By this resolution the Committee did not mean to underrate the necessity for improved secondary instruction. On the contrary, they believe that the remedy for the defective technical education complained of in the upper classes lies chiefly in improved teaching of science in these secondary schools. With this object they recommend that science be taught in all secondary schools; that new science schools be created, and that this be done in some such manner as is recommended by the Schools Inquiry Commission.

While the Committee recommend that new science schools or colleges should be established, they observe that caution must be exercised that they should not be so placed as to compete on unequal terms with existing institutions, which have owed their creation to private munificence or enterprise. On the contrary, these older institutions should receive assistance analogous to that given to new schools and colleges, conditionally on their providing analogous courses of instruction. Although competition is desirable, special caution is necessary when Government is one of the competitors. Thus it would be important that no new science-school or college endowed by Government should be established so as to compete with University College or King's College, so long as their efficiency is curtailed for the want of similar endowments. It is, on the contrary, most desirable that such institutions as these should participate in the funds which ought to be devoted to giving the highest grade of scientific instruction. It is a favourite doctrine in England, that those who wish for any benefit should pay for it, but experience, both here and abroad, shows that no educational institution of the highest grade is really self-supporting, that is to say, the receipts never cover the expenses, leaving a margin as dividend on capital. Schools of the highest grade, to exist at all, must therefore be endowed, and no schools can better deserve Government assistance than those which have already done so much with the assistance of private munificence only. The Committee therefore do not wish to restrict all assistance given to science-schools or colleges to the forms proposed by the Schools Inquiry Committee; on the contrary, they desire to see Government assistance given wherever local enterprise or munificence directed to the establishment of the highest grade of science-schools or colleges prove that a real desire for good education exists. The assistance given to Scotch Universities, and that expected by Owens College (in Manchester), are illustrations of the spirit in which the Committee wish the Government to act.

When existing colleges have organised the proposed courses of study, and when the new schools, leading to those colleges, or giving analogous preparation for the scientific professions, have been established, it will be necessary that the proficiency of the students and the efficiency of the teaching should be tested by methodical examinations; and, in order that students should be induced, by a tangible reward, to present themselves well prepared for these examinations, it is desirable that diplomas or certificates should be granted for approved excellence. There would be serious objections to the granting of diplomas to civil engineers, architects, &c., if these diplomas were supposed to certify that, after a merely scholastic education, the students were ready to practice their professions, but there are no objections to certificates which simply attest that the student has attained such proficiency in his theoretical studies that he is fitted to enter on a practical pupilage with advantage to himself and his employer. The certificates will also be a valuable recommendation in early professional life, if they are granted with discretion. They might either be granted by some one public examining body in each profession, or by the various colleges where the higher studies are carried on. The Committee prefer the latter plan, as less likely to lead to one monotonous system of teaching; but they feel that certain guarantees must be taken, lest a sort of Dutch auction should occur, in which the inferior schools and colleges would bid for pupils by granting certificates for smaller and smaller acquirements. Such conduct would no doubt bring its own remedy in time, but, to avoid the occurrence of the evil, the Committee consider that the examinations at each school and college should be conducted with the assistance of two independent examiners, one appointed by the Government and one by the leading professional institute belonging to the profession with which the examination was connected. These two examiners should also report on the proficiency of the students at the various institutions, and would thus perform the office of inspectors, without subjecting the professors of the higher colleges to any degrading supervision.

After this good scientific instruction, tested by examination, comes the pupilage in all cases, and after the pupilage it is desirable that voluntary public examinations should be held, with the view of testing whether the young men have really profited by their pupilage. This examination, which should be partly practical and partly theoretical, might be conducted by similar boards of examiners to those specified above; and diplomas, which would then express real proficiency in the several professions, should only be granted to young men of undoubted merit. Severe examinations of this type are conducted at Carlsruhe and other large polytechnic schools on the Continent.

The above recommendations are an expansion and explanation of the resolutions:—"*That it is desirable that the higher scientific instruction should be tested by public examination, and that the proficiency of persons who pass these examinations should be certified by diploma;*" and "*That the preparation for the businesses considered by the Committee is not sufficient until due scientific instruction has been followed by practical pupilage in efficient works.*"

When, however, a methodical course of study has been rendered possible for each profession, and examinations have been instituted for testing the proficiency of students, it will at first be difficult to fill the classes of the new schools, and to induce young men in any numbers to present themselves for examination. It is incumbent on all those who really believe in scientific teaching to prove their faith by giving a practical value to the certificates obtained by students. This can be done only by the employers of labour, who must at first act on faith only. Hitherto no class of young Englishmen, trained in the manner proposed, has existed. In order to induce the rising students to follow this methodical training they must see that the few who take that course do find employment more readily than those who do not. The employers of scientific labour can give an enormous impulse to scientific training by showing a real preference for young men who have passed through the courses of study recommended. Thus engineers and architects ought to receive pupils more readily who are well trained; they might reduce their premiums for such pupils; they should grant free pupilships as rewards for very successful public examinations; they might give privileges in their professional institutes to the holders of diplomas. The Committee "*recommend employers of labour and others in the habit of taking pupils, apprentices, and clerks, to give the preference as far as possible to those adducing evidence of the possession of adequate instruction in the sciences applicable respectively to their professions or occupations.*"

As the greatest of all employers of labour, it is most desirable that Government should lead the way in this matter, and give some official value to certificates and diplomas of real value. From the examiners appointed to assist in the college examinations on the plan above described, they would obtain reports of the real value of each certificate or diploma; they might therefore allow, in competitive examinations, those students who had taken certificates or diplomas to count them as equivalent to a certain number of marks. They would thus encourage methodical study to an extent unapproachable by any other method, and would render the final competitive examinations quite unobjectionable, since no one could then complain, as Mr. Arnold complains, that while foreign governments encourage great public schools and methodical study by rendering these essential to the candidates for the vast number of appointments in their patronage, our Government only encourages professional crammers. If we are to fill public schools with a number of pupils equivalent to those in the public schools on the Continent, we must render public school education as essential to a man's career in England as it is abroad.

With a similar object, nominations, and, in the opinion of some of the Sub-Committee, direct appointments, might be given as the reward for taking the highest honours at these examinations. The general scheme, therefore, of technical education for the upper classes is this:—

The lad should receive his secondary teaching in science schools of a class to be created, completing his theoretical education, at about the age of 18, either in the higher forms of these schools or at higher colleges. During the last two or three years of his scholastic training he should follow courses of study arranged with a view to the profession which he may select, and consisting chiefly of the same pure sciences in all cases. In the last year of his scholastic teaching he should receive some instruction in the application of science to his special profession. On leaving these schools or colleges he should pass an examination, and receive, if successful, a certificate. He should next enter an office or works as a pupil, and on, or at some time after, the completion of his pupilage, he should present himself for a further and severer examination, in which his practical proficiency would be tested, and for which it would be necessary that he should study, either in evening classes or by himself, some advanced branches of science connected with his profession, and, on passing his examination, might receive a diploma.

Lastly, it is essential that young men who do enter their professions in this way should gain some immediate tangible advantages, such as can be appreciated by inexperienced youths and by ignorant or prejudiced parents.

In addition to this general scheme, or, in substitution for parts of it, many valuable suggestions are contained in the reports from members of the Sub-Committee, but as these have not been adopted by the Sub-Committee, these recommendations are not embodied in this report. Each report will receive the consideration due to the names appended to it. Attention may, however, be drawn to the suggestion, for the mercantile marine, that young officers should qualify as instructors and teach men while afloat, receiving payment on results and for mercantile

education generally; that the merchants of London and the chambers of commerce should appoint permanent committees to promote and supervise commercial education, raise funds, appoint professors, examiners, &c. For the details of these schemes the Appendix must be consulted.

No equally elaborate scheme has been prepared for the education of artisans. It has been felt that their education depends on the primary and secondary education given throughout the country. Until these are materially improved it will be impossible for the adults to follow any really scientific teaching. At present they have difficulty in performing simple arithmetical operations, in taking notes with rapidity, and in understanding diagrams. If they left primary schools able to do these three things thoroughly, they would have received a good preparation for the workshop and for future study. To attain this object existing teaching must be improved generally. Arithmetic must be taught as a branch of mathematics, not merely as a curious and complex series of empirical rules; plane geometry and algebra must be added, in the higher classes of the primary schools, and in the third-grade secondary schools,* for lads of 12 and 13; and mechanical or linear drawing must be taught to an extent for which even teachers would not at this moment be found.

In the lower grades of education, as in the higher education, it is essential to lay a sound basis, teaching the elements of science thoroughly. The sons of workmen of all grades should learn the elements of mathematics and mechanical drawing. In the higher classes of the third grade secondary schools the elements of experimental chemistry and physics should be added to the curriculum. This knowledge will enable men in after life to read and understand books, and learn practical rules which they now can neither understand nor apply.

The report of the Schools Inquiry Commission if acted upon will provide this education, and the Sub-Committee feel that they cannot do better than lend that report their most hearty support. The Commission state broadly that "the most urgent educational need of the country, is that of good schools of the third grade, that is of those which shall carry education up to the age of fourteen or fifteen." They note the failure of existing endowed schools, allude with approval to the existing Bristol trade schools; but they say "such schools are unquestionably not numerous nor well distributed." Making allusion to the alleged defective technical education among our artisans, they proceed, "we are bound to add that our evidence appears to show that our industrial classes have not even that basis of sound general education on which alone technical instruction can rest. It would not be difficult, if our artisans were otherwise well educated, to establish schools for technical instruction of whatever kind might be needed. But even if such schools were generally established among us, there is reason to fear that they would fail to produce any valuable results, for want of the essential material, namely, disciplined faculties and sound elementary knowledge in the learners. In fact, our deficiency is not merely a deficiency in technical instruction, but, as Mr. Arnold indicates, in general intelligence, and unless we remedy this want we shall gradually, but surely, find that our undeniable superiority in wealth, and perhaps in energy, will not save us from decline. If we could provide good schools for our artisans up to the age of fourteen, then those who showed aptitude for special industrial pursuits would be in a fit condition to enter on the needed special study. But our first object should be to enable the whole of this large population, whose education we are now considering, to cultivate their children's understandings and make them really intelligent men."

"We need schools that shall provide good instruction for the whole of the lowest portions of what is commonly called the middle class, and we cannot overstate our sense of the importance of the need. These are the schools that we have called schools of the third grade. It recommends that "in every town large enough to maintain a day school, it is desirable that there should be at once provision for ten boys per thousand of population, with a power of extension;" and "that of the whole presumed demand half at least should be assigned to the requirements of scholars of the third grade."

After recommending that every town of 5,000 inhabitants should have a school of the second grade, it recommends that *every town* should have a school of the third grade. No school of the third grade should be allowed to charge a fee above £4 4s. (nor below £2 2s.) per annum, the Commission being distinctly averse to gratuitous instruction. The funds by which these objects are to be attained, may be provided from the same sources as those already shown to be applicable to schools of the first grade, but the Commission further recommend that "every parish should be allowed to levy a rate for building and keeping in repair a school of the third grade; and if two or more parishes wish to combine for the purpose, they should be enabled to do so." If the report of the Schools Inquiry Commission be acted upon, the workmen of this country will be provided with a thoroughly sufficient number of well organised public schools, giving that elementary scientific instruction which must form the basis of all technical education.

The Schools Inquiry Commission further recommend the establishment of exhibitions, by which the ablest lads at the third grade schools might be passed onward to the second grade and first grade schools, and by which also the third grade schools would be fed from the primary schools of the country.

The Sub-Committee differ from the Schools Inquiry Commission as to the retention of Latin in these third grade schools, intended chiefly for workmen. They consider Latin clearly out of place in these schools, and believe that for every purpose the time of the young workman would be far better occupied in the study of English, and the natural sciences, and mathematics.

The proper sequel to this education is apprenticeship accompanied by evening classes. In these evening classes physics and chemistry might be added to the curriculum given above; also other natural sciences and foreign languages where a demand existed for these subjects. Even if not otherwise useful, these classes would bring culture within the reach of workmen. The teaching should not be gratuitous; it should not consist of lectures only, but be accompanied by frequent verbal examination and by written exercises; it should be given by regular teachers, connected, where possible, with the higher grade schools. Where new chairs are endowed by Government or other bodies, a condition might be attached to the endowment that evening classes should be taught by the professor or his assistant, and the fees derived from those classes should belong to the professor. Access to libraries and museums in connection with the evening classes, and independently of these, is demanded by workmen, and cannot be otherwise than beneficial. Prizes and honorary distinctions in connection with these evening classes would be useful, and mechanical drawing especially should be liberally encouraged in this way, since experience abroad and at home has shown that great proficiency can be attained by workmen in this art, and it is one which very greatly facilitates the expression of their ideas and quickens their intelligence in understanding the work required from them.

Young workmen living frequently as lodgers in the houses of married workmen have now few facilities for study, and we believe that the creation of lodging houses for these unmarried men, in connection with evening classes systematically arranged, would greatly assist young workmen in their studies. Thus each man might have his own furnished room as a bedroom and study.

* *Vide* Schools Inquiry Commission Report.

Meals might be provided in common halls at a small expense; and regular evening classes might be held the attendance at which should be a necessary condition of residence. A library, reading-room, and museum would complete the establishment, which would thus offer to our workmen something analogous to the collegiate life of our great universities. Notoriously vicious conduct would be followed by expulsion, and students who failed to pass satisfactory examinations would also lose the privilege of residence. The classes might also be open to married men and other non-residents on the payment of sufficient fees. Gratuitous instruction and board might be given to a certain number of men in the form of scholarships and exhibitions, and certificates should be granted to all who pass good examinations. Some portion, if not all, of the funds required for an experimental college of this kind could be provided by taking advantage of the "Act to enable the Public Works Loan Commissioners to make advances towards the erection of dwellings for the labouring classes."

It appears that workmen are beginning to organize evening classes for themselves, appointing their own teachers and framing their own rules and terms of admission. Thus the trade union of Amalgamated Carpenters and Joiners have succeeded in establishing large classes both in London and Manchester. The chief difficulty met with by these men has been in finding suitable rooms for these classes. These efforts are especially worthy of encouragement, and the form of encouragement which would least interfere with the independence and self-reliance of the men would be assistance in finding meeting rooms, either by paying the rent or by the erection of suitable buildings. It would indeed be lamentable if a movement of this kind were stinted in growth from the mere want of suitable places in which instruction could be given. Mechanics' Institutions might offer accommodation in some cases, and grants might also be made by Government through the department at South Kensington. Suitable guarantees that the rooms would not be used for improper purposes could easily be devised.

Here the Sub-Committee would call attention to the great necessity there is for Sailors' Institutes in the Colonial and Indian ports, in many of which there are always from one to three thousand officers and seamen needing a building where their leisure time may be spent in self culture, and where the proposed instructors could hold their classes.

In conclusion, the following series of resolutions express the recommendations of your Committee as respects the action of the government of existing colleges or universities and of the leading men in each profession or business considered by the Committee. An expansion of each of these resolutions has already been given, and should the wording of any one resolution appear ambiguous, the meaning attached to that resolution is to be gathered from what has been said above :—

It is desirable that Government should encourage systematic scientific instruction by the following measures :—

1. *By adopting the recommendations of the Schools Inquiry Commission, for the introduction of the teaching of natural science into all secondary schools, and for establishing new science schools of the first grade, which schools should be on all points on a footing of equality with the endowed classical schools.*

2. *By co-operating with universities and colleges in holding examinations, which are or may be established for the purpose of conferring certificates or diplomas in connexion with systematic studies, intended to educate civil engineers, mechanical engineers, officers of the mercantile marine, metallurgists, miners, naval architects and marine engineers, architects, merchants, chemists, and agriculturists.*

3. *By giving some official value to those certificates or diplomas, such as allowing certain diplomas to represent a given number of marks in competitive examinations.*

4. *By putting at the disposal of the leading colleges which give methodical courses of scientific instruction, and diplomas of recognised value, a limited number of nominations annually.*

5. *By assisting old and new endowments where local subscriptions or donations prove the value set on the instruction proposed or given.*

6. *By instituting night classes for workmen in connection with all new scientific endowments, with access to a library.*

7. *By providing free libraries suitable for the use of the students in night classes generally.*

8. *By providing suitable meeting-rooms for night classes organised among workmen, for the purpose of obtaining scientific instruction.*

9. *By according liberal prizes to workmen for excellence in mechanical drawing.*

10. *By taking steps to extend and improve primary education.*

It is desirable that colleges should encourage systematic scientific instruction by the following measures :—

1. *By instituting methodical courses of scientific teaching, adapted to students intending to enter a profession or business among those which have been enumerated above.*

2. *By the establishment of diplomas, corresponding to the several courses of study in conjunction with Government, and with the leading Institutes belonging to each profession.*

3. *By the establishment of fellowships and scholarships in connection with those diplomas.*

It is desirable that the leading civil and mechanical engineers, architects, merchants, shipowners, chemists, manufacturers, and agriculturists, should encourage systematic scientific instruction by the following measures :—

1. *By the creation of scholarships and fellowships in connection with those schools and colleges where methodical courses of instruction are given.*

2. *By co-operating in the examinations for diplomas.*

3. *By giving a practical value to those diplomas, such as would be evinced by a reduction of premiums to intending pupils holding such diplomas, and by attaching weight to the possession of a diploma when choosing among candidates for employment.*

4. *By granting distinct privileges, in connection with the professional institutes, to all holders of recognised diplomas.*

We here repeat the resolutions already quoted in order that all the formal resolutions may be found together :—

For the purposes of discussion, technical education should be deemed to exclude the manual instruction in Arts and Manufactures which is given in the workshop.

That the term "technical education" is understood by the Sub-Committee to mean general instruction in those sciences, the principles of which are applicable to various employments of life.

That technical instruction, as defined above, should not as a rule be given in separate professional institutions, but in institutions established for general education.

That, with a view to the development of a system of scientific education, it is desirable that schools be established having for their main object the teaching of science as a mental discipline. These science schools should prepare some youths for the higher courses of a college, and other less ambitious pupils for their professional pupilage.

That the subject of secondary instruction having been reported upon ably and deliberately by the Schools Inquiry Commission, the Committee do not feel it necessary to enter into the details of this subject, while they desire emphatically to express their opinion of the necessity for the introduction of scientific teaching in all secondary schools.

That it is desirable that the higher scientific instruction should be tested by public examination, and that the proficiency of persons who pass these examinations should be certified by diploma.

That the preparation for the businesses considered by the Committee is not sufficient until due scientific instruction has been followed by practical pupilage in efficient works.

The Committee recommend employers of labour and others in the habit of taking pupils, apprentices, and clerks,

to give the preference as far as possible to those adducing evidence of the possession of adequate instruction in the sciences applicable respectively to their professions or occupations.

Your Committee have reserved for separate consideration the technical education of those who are producers of works of fine or decorative art, or directors of art manufactures, understanding by that last term manufactures in which beauty or ornament is one of the chief objects aimed at.

It is necessary to bear in mind that for the production of works of an æsthetic character, scientific principles occupy a subordinate position, while a knowledge of the details of execution is desirable for those who design or guide the work of others. Moreover, it must be borne in mind, that the taste of those to whom works of beauty appeal, is far more fluctuating than the demand for productions in which utility is alone considered.

Your Committee are of opinion that one of the first conditions of progress is, the cultivation of artistic knowledge and taste in all classes of society.

With this object in view, no less than with a view to the technical education of the art-workman, provision should be made for the teaching of drawing in all schools, primary and secondary, as a branch of general education, in order to train the eye and hand, and in order to cultivate habits of observation. It is essential that drawing should be part of the regular school course and not an extra lesson; and, further, that it should be taught intelligently, not from mere copies, but from real objects.

The art-workman needs, in addition to a power of freeband drawing, an acquaintance with geometrical drawing, in order that he may be able to execute work correctly, in accordance with the designs of the artist who directs him.

For artists, designers, and directors of art manufactures, the education should be a liberal one, in order that they may understand the feelings of those on whom they desire to make an impression. Their education should also be, to some extent, scientific, in order that they may have a knowledge of the properties of the materials they employ, and be able to adapt those materials to the structure of the objects produced, and those objects to the uses for which they are intended.

The recommendation already made with reference to other professions, namely, that the period of pupilage, or the earlier stages of practice, should be preceded by a special attention to those branches of knowledge which have a direct relation to their art, applies to the technical education of those who are concerned with artistic work. In this case that knowledge should include not only scientific principles, but also a history of the various forms in which, prior to any scientific theory, some of the noblest conceptions have found their expression in works of art.

It is therefore desirable, both for the artist workmen and for those engaged in the highest branches of art, that opportunity should be given by access to museums and to evening classes, for the study both of the theory and history of art.

Your Committee are of opinion that the Universities may render great service to the technical education of those engaged in artistic pursuits, by the recognition of art as an element in general education, and by professorial lectures. Some steps in this direction have been taken, by the regulations attaching importance to drawing in the Local Examinations; but your Committee would gladly see the practice carried further, and applied to the higher stages of academical education. They cannot doubt that the study of works of ancient and modern art would have a tendency, in connection with literature, to diffuse culture throughout the nation, and to raise the standard of technical education.

(Signed),

W. HAWES, *Chairman of the Sub-Committee.*
P. LE NEVE FOSTER, *Secretary.*

APPENDIX.

Courses of Study recommended by Gentlemen whose names are subscribed to each Course.

Agriculture and Gardening.

A THREE YEARS' COURSE.

First Year.

Mathematics.	Physical Laboratory Practice.
Physics.	Chemistry of Non-metallic Elements.
Mechanical Drawing.	

Second Year.

Chemistry of Metallic Elements.	Chemical Laboratory Practice.
Organic Chemistry.	Elements of Natural History or Biology.

Third Year.

Mapping and Surveying.	Technical Chemical Laboratory Practice.
Applications of Science to Agriculture.	Agricultural Machinery.

E. Frankland.
D. S. Price.
A. W. Williamson.

Chemical Manufactures.

A THREE YEARS' COURSE.

First Year.

Mathematics.	Physical Laboratory Practice.
Physics.	Chemistry of Non-metallic Elements.
Mechanical Drawing.	

Second Year.

Chemistry of Metallic Elements.	Analytical Chemistry in Laboratory.
Organic Chemistry.	

Third Year.

Lectures on the student's own branch of Technical Chemistry.	Technical Laboratory Practice.
	Machinery.
	Minerology.

E. Frankland.
D. S. Price.
A. W. Williamson.

Metallurgist.

A THREE YEARS' COURSE.

First Year.

Mathematics.	Chemistry of the Non-Metallic Elements.
Physics.	
Physical Laboratory Practice.	

Second Year.

Chemistry of Metallic Elements.	Mechanical Drawing.
Mineralogy.	Laboratory Practice.

Third Year.

Metallurgy.	Metallurgical Laboratory Practice, including Assaying.
Applied Mechanics	

E. Frankland.
D. S. Price.
A. W. Williamson.

Miners.

A THREE YEARS' COURSE.

First Year.

Mathematics.	Physical Laboratory Practice.
Physics.	Non-metallic Elements.
Mechanical Drawing.	

Second Year.

Geology. Mineralogy.	Chemical Laboratory Practice. Mechanical Drawing.

Third Year.

Mining. Applied Mechanics. Geology.	Surveying. Assaying.

E. Frankland.
D. S. Price.
A. W. Williamson.

Civil Engineer.

A TWO YEARS' COURSE.

[No student should be allowed to enter on a course of special study until he has passed an examination, proving that he has received a sound preliminary education not having special reference to his profession.]

Pure Mathematics	Algebra. Plane and Solid Geometry. Trigonometry.
Natural Philosophy	A general course on the properties of matter, and some one branch, such as Heat, Optics, Electricity, &c.

Chemistry (inorganic), with laboratory practice.
Geology, including instruction in the field.
Mathematics applied to Mechanics.
The application of Science to Civil Engineering.
The application of Science to Mechanical Engineering, Surveying, and Levelling.

Drawing	Geometrical Projection. Mechanical Drawing. Plans and Surveys.

After passing an examination in these subjects the student should enter a civil engineer's office as pupil, and examinations should be instituted by which his knowledge, at the end of his pupilage, could be tested. These examinations should be on special and limited subjects, but in these subjects they should be of a severe and searching character. They should comprise two groups of subjects—theoretical and practical—out of which the candidate should select one in each group.

Group 1.—Practical Engineering.

(*a*) The preparation of designs, specifications, and contents for some civil engineering work.
(*b*) The design of machinery, &c.; complete drawings, specifications, and estimates.

Group 2.—Applied Science.

(*a*.) Pure Mathematics (higher calculus).
(*b*.) Mathematics applied to Mechanics.
(*c*.) Chemistry, Geology, or some other branch of experimental physics.
(*d*.) Telegraphy.

3rd. Students should not be encouraged to select more than one subject in each group.

All these examinations should at present be voluntary, but it would be most desirable that the leading engineers should refuse to receive as pupils young men who had not passed an examination showing their fitness to enter the office with advantage to themselves.

Fleeming Jenkin.

Mercantile Marine.

Mechanical Drawing. Mathematics. Physics, including Meteorology and Steam. Physical and Topographical Geography.	Political Economy. Law—Maritime, commercial, and international. Languages.

Note.—That with regard to the scheme of instruction for the officer of mercantile marine, it is impossible to define the length of the course, seeing that the apprentices, seamen, and officers of the mercantile marine only return to the United Kingdom after more or less long intervals of absence and remain there only for a short time. Any course of instruction for these persons must necessarily therefore be indefinite as to the time of its duration.

A. P. Ryder, Rear-Admiral.

Admiral Ryder and Captain Toynbee, to whom this subject was referred, brought up the two following reports:—

We beg to report that in compliance with the resolutions 1 and 2 of the minutes of April 8, we propose to arrange the subjects for the higher course of instruction for members of the mercantile marine in the following order. We have placed the subjects in what we consider their order of relative importance:—

Subjects.	Preliminary Amount of Knowledge.
1. Law—Common, Commercial, International.	To have a good knowledge of the disciplinary clauses and a fair knowledge of the other clauses of the Mercantile Marine Act, and of a special elementary text-book on these branches.
2. Mathematics	Colenso's Arithmetic, First Book of Euclid, Algebra to Simple Equations.
3. Physics, including meteorology and steam	Use of mathematical instruments, preliminary chapters of text-books on steam.
4. Physical and Topographical geography..	
5. Political economy....	
6. Languages..........	Easy exercises in any one modern language (European.)
7. Mechanical drawing..	

In reply to the second resolution (2nd May, 1868), we beg to report that it will, in our opinion, be necessary to open night classes in the immediate neighbourhood of the docks at the sea-ports, for the secondary and higher instruction of the apprentices, seamen, and officers who are employed on board their ships all day; and that instruction in the higher course should also be given in the Science Schools at the sea-ports in the day-time, for the benefit of those officers, &c., who may be out of employment, and therefore able to avail themselves of instruction during the day.

We are of opinion that the course of secondary instruction which should be given to apprentices and seamen must, to a certain extent, be governed in practice by the nature of the examination required by the Board of Trade for the second-mate's certificate, which examination should, in our opinion, be considerably changed and extended, or it will be very difficult to induce more than a small minority of the young seamen to do more than prepare for the Government certificate. To study subjects not included in that examination, will appear to these young men to involve not only loss of time, but also to endanger their success at their final examination, as their attention, during the small portion of their time which they can devote to study, will be diverted from those subjects that alone are absolutely necessary for their Government examination. Under these circumstances we beg to submit that, at this stage of our proceedings, Mr. Gray, of the Board of Trade, be invited to join the Sub-Committee, so that we have the advantage of learning to what extent it is probable that the

Board of Trade may be induced to extend and raise the examination for second-mate.

A. P. RYDER, Rear-Admiral.
H. TOYNBEE.

In compliance with the last resolution in the minutes of the 8th of May, we beg to recommend that the instruction for adult officers and seamen be provided as follows, viz.:—

1. That *special classes* be established at the science schools, which (have been opened at some towns, and) ought to be opened at all seaport towns, for the purpose of giving instruction to adult officers and seamen.

2. That these classes be both day and night classes.

3. That *special day and night classes* for adults be also established at the schools which we have already recommended to be opened in the immediate neighbourhood of the docks.

4. The instruction offered at the science schools will probably be of a higher order, and more suitable to officers, while the instruction offered at the dock schools will be more suitable for the seamen.

5. There is this especial difficulty in the way of bringing instruction of a high order within the grasp of adult *seamen*, viz., that they have so little time at their disposal in harbour, and at sea they have no instructor. This applies, but to rather a less extent, to the young officer.

6. The large mass of adult seamen between say the ages of 18 and 30, have received such a wretchedly meagre edncation that we have little hope of making any great impression upon them; still, here and there we find men who are able and willing to learn.

7. The result of careful experiments tends to show that about $\frac{1}{6}$th of a ship's company, or 17 seamen in 100, are able and willing to take pains with themselves. This is probably about the proportion that are required to feed the officer class; but education would, of course, be beneficial for all.

8. Some officers of the Mercantile Marine have not considered it to be a waste of time, or otherwise than a creditable and useful mode of occupying it, to devote a portion of each day to the instruction of the officers, seamen, and apprentices under their orders.

9. It is on systematic instruction given *afloat* at spare hours that we must rely, if the adult seamen are to be instructed efficiently, and if the lads are to retain the knowledge which they have acquired on shore at the proposed night schools.

10. We recommend, therefore, that the Board of Trade be requested to take the necessary steps for encouraging the junior officers of the mercantile navy to qualify as *Instructors*, and that the seamen be invited to avail themselves of the opportunity of having among their officers a certified instructor, to study under him at such hours as the captain may permit.

11. The payment to the *Instructor*, if wished for, to be fees deducted from the seamen's wages, and a small payment on results from the Committee of Council on Education.

12. The payment on results to be measured by examination of the seaman's progress, to be held at the ports.

13. This proposal, if adopted, would tend, while it afforded an opportunity to seamen and apprentices of studying at sea, to raise also the officers; for if many of them were qualified as *Instructors*, they would become thoroughly and intimately acquainted with the subjects they had mastered, and thus become better able to acquire the more advanced knowledge instruction in which we propose they should be offered at the science schools at the seaports.

ALFRED P. RYDER, Rear-Admiral.
HENRY TOYNBEE.

Mr. Thomas Gray, one of the Assistant Secretaries to the Board of Trade, having joined the Committee as requested, has added the following remarks:—

I fully concur in the opinions expressed by Admiral Ryder and Captain Toynbee in the last paragraph of their report.

That the second mate's examination "should be considerably changed and extended if possible," I have long held; and have often stated: but how far it is possible and expedient to extend it, and if it be possible and expedient, whether the extension should be made at once or by degrees, are questions for the advice of the practical scientific officers of the department.

It has been urged, and I think with reason, that the second mate's examination (or the first examination passed by an officer of the Mercantile Marine, by whatever name that examination may be known), should be such an examination as will promote, and as far as possible ensure, a careful study of the elements of his profession, and this while the applicant for examination is still young, and his mind free, and while he has good opportunities of attending to study and acquiring knowledge. It is urged, that if the standard of the second mate's examination is raised, we shall get a superior class of young men to join the merchant service. On the other hand, it must be borne in mind, that as the employment of certificated mates in foreign-going ships is compulsory by law, the effect of raising the standard (unless it be very carefully and judiciously done), may be to stop the supply of young officers as second mates, and to cripple our commerce.

It is sometimes alleged that, with some bright exceptions, the officers of our Mercantile Marine are, as a class, below the officers of the Mercantile Marine of other countries in point of scientific knowledge, and knowledge of accounts and of Mercantile Marine law. Whether there is or is not any foundation for such an allegation, I am, after careful inquiry, utterly unable to say, but if there is any foundation for it, then I know of no steps so likely to be attended with success as to raise the standard of excellence in the junior ranks.

The rules for the examination of masters and mates of all maritime countries are now being collected and translated, and the subject of examinations is under the consideration of the Board of Trade. A careful examination and comparison of the British and foreign rules will be of great assistance to the members of this Sub-Committee.

THOMAS GRAY.

THE NAVAL ARCHITECT AND MARINE ENGINEER.

A THREE YEARS' COURSE.

First Year.

Pure Science	Mathematics. Physics. Chemistry.
Applications of Science	Descriptive geometry. Strength of material. Mechanics of structure. Elements of machinery.

Practical work, in laboratories and drawing office.

Second Year.

Pure science	Mathematics. Physics. Chemistry.
Applications of science	Constructive geometry. Resistance of fluids. Hydrostatics of ships. Nature of fuel. Seamanship. The marine engine.

Third Year.

Pure science	Mathematics. Chemistry. Natural History.

Applications of science	Hydrodynamics of ships. Naval designs. Ship-building and launching. Equipment and Stowage. Armament and tactics. Metallurgy.

Practical work to be conducted during winter in laboratories.—Drawing offices, and collections of models of ships and marine engines.

Practical work to be conducted during the summer half-years in the royal dockyards, arsenals, and engine factories.

Practical work to be afterwards conducted during several long voyages at sea, both in the service of the ship and in the service of the engine-room.

J. Scott Russell.

The Mechanical Engineer and Machinist.

A THREE YEARS' COURSE.

First Year.

Pure science	Mathematics. Physics. Chemistry.
Applications of science	Descriptive geometry. Elements of mechanism. Strength of materials of construction.

Practical work in laboratories and drawing office and museums to accompany each study.

Second Year.

Pure science	Mathematics. Physics. Natural history.
Applications of science	Constructive geometry. Prime movers and steam engines. Nature of raw materials. History of inventions. Elements of mechanism.

Practical work in laboratories and drawing office and museums to accompany each study.

Third Year.

Pure science	Mathematics. Ultimate mathematical physics. Political economy.
Applications of science	Statics of machinery. Hydraulic machinery. Prime movers. Electro-magnetic mechanism. Engine tools. Metallurgy. Design of factories.

Practical work to be carried on in laboratories, drawing office, and museums, and collections of machinery during the Session.

Practical work in factories and workshops should, if possible, alternate with study in periods of six months.

At the end of apprenticeship a course of travel, with work and study, should be recommended.

J. Scott Russell.

The Architect.

A THREE YEARS' COURSE.

First Year.

Pure science	Mathematics. Physics. Chemistry.
Applications of science	Descriptive geometry. Strength of material. Statical construction. Principals of style and design. Surveying and measurement.

Practical work in laboratories, drawing office, and museums to accompany each subject of study.

Second Year.

Pure science	Physics. Natural History. Physiology of health. Psychology.
Applications of science	Constructive geography. Principles of carpentry, metal, stone work. Mechanism of buildings. Principles of beauty in buildings. History of architecture.

Practical work in laboratories, drawing office, and museum to accompany each study.

Third Year.

Pure science	Mathematics of curve lines and surfaces.
Applications of science	Light and shade. Perspective. History of building materials. Health of buildings. Domestic economy of buildings. Principles of proportion and decoration. Practical design.
Practical work to be carried on during these three years in College, and continued afterwards.	In the Chemical laboratory. " Mechanical laboratory. " Drawing office. " Collection of drawings. " Collection of models and casts. " Museum of building materials and inventions. " Apprenticeship on works. " Foreign—French.

J. Scott Russell.

Our names having been added to the Committee after the special courses herein developed were drawn up, we venture to remark that several of the subjects which have been grouped under the head of "applications of science," as, for instance, "principles of style and design," "principles of beauty in buildings," "history of architecture," and "principles of proportion and decoration," are not, in our opinion, such as can be taught theoretically as the result of scientific research. On the other hand, some important branches seem to have been overlooked, to which we desire to call attention, as being important elements in the training of an architect, but which it is difficult to provide for efficiently under the system of pupilage. These are—

The study and delineation of ancient monuments.
The visiting and examining buildings in progress.
The study of ornament and of the human figure.
Modelling.
Perspective.
Decorative colouring.
Landscape painting.

We would suggest that students might be encouraged to attain a proficiency in the above by scholarships and travelling studentships.

(Signed)
John P. Seddon, Hon. Sec. R.I.B.A.,
R. Phené Spiers, Pres. Architect. Assoc.

The Merchant.

A TWO YEARS' COURSE.

First Year.

Languages:—English, French, German, Spanish, Italian; or English and any two foreign languages.
Mathematics, logarithms, statistics, accountancy.

Commerce	Principles of commerce. History of commerce. Banking, currency, foreign exchanges.

Geography—Physical and political.
Economic science—Principles of political economy.

Commercial Law	Agency. Partnership. Joint stock companies. Contracts of sale. Bills of exchange. Contracts of affreightment. Contracts of marine insurance.

Second Year.

Languages:—English, French, German, Spanish, Italian; or English and any two foreign languages.

Mathematics, elements of the theory of probabilities, logarithms, statistics.

Commerce	History of commercial and banking legislation. Institutions of credit and banking.
Geography	Physical and political.
Economic science	Production, labour, wages. Capital and wealth. Finance, taxation, the funding system.
Commercial law	Continuation of different branches of commercial law. Law of patents and copyrights. Life and fire insurance. Bankruptcy law. Law of arbitration.
International law.	Rights of neutrals. Rights of belligerents. Rights and duties of consuls.

Jurisprudence, including the principles of ethics.
Chemistry.
Geology.

Note.—As regards the qualifications necessary for a student entering on the above course, it is desirable that he should have acquired the knowledge of—

English—Commercial correspondence.
Latin.
Foreign languages—French, Spanish, Italian, German, or any one of them.
Mathematics — Elements of Algebra; elements of Geometry.
Drawing.
Physical geography.
Nature and history of commercial products.

With a view to the practical adoption of the suggestions relating to the technical education of the merchant, it is recommended:—

1. That the merchants of the City of London and the Chambers of Commerce be requested to form Committees for the purpose of promoting and supervising commercial education.

2. That the Committees so formed should provide a fund for the maintenance or subvention of classes on Commerce, Economic Science, and Commercial Law, in connection with any institution providing instruction in the other branches of science required for the two years' course.

3. That upon an examination, conducted jointly by members of such Committee and members belonging to such institutions, certificates of honour and merit be awarded in relation to commercial education.

Observations upon the Two Years' Course Proposed for the Higher Grade of Commercial Education.

It is assumed that the students proposing to enter upon these courses have had a good secondary education before leaving school, and that they are qualified, when entering upon their commercial career, to take up the various subjects proficiency in which is indispensable, before they can enter upon the higher grade of scientific or technical commercial instruction. The first question, then, is, how is this proficiency to be obtained?

A young man in a merchant's office has only his early mornings, evenings, and holidays to devote to study. To study successfully at such times requires a place for reading—a library—courses of lectures—and a recognised body of examiners, to test, by half-yearly examinations, the progress and attainments of each student, previously to granting certificates, that he has passed an examination in the higher grade of commercial education.

It may be safely asserted that no organisation now exists fit to direct and to test the scientific education of the number of young men who would voluntarily enter upon these courses of study, and submit to severe examinations, had they the opportunity afforded them for so doing.

It is considered as essential to the attainment of success from entering upon such courses of education, that the student should be at the same time practically engaged in the business of life, should have determined upon his future occupation, and be of an age to select such of the courses proposed as will best aid him in his future prospects.

If this view be correct it is necessary to suggest machinery by means of which the required knowledge may be obtained without unduly interfering with the duties of the office in which the student may be employed. This may be found in the arrangements now in operation for the study of the law and for the study of medicine, which appear to be capable of practical application to the study of the science of trade and commerce.

The Law Institution does for students in the law that which Chambers of Commerce, in towns where they exist, or which an Institute of Merchants in London or other places where they do not exist, could and ought to do for commercial students. Students in medicine are obliged to pass examinations before the most distinguished members of their profession, beginning with the Society of Apothecaries, and terminating with the Colleges of Surgeons and Physicians.

Courses of lectures on all the subjects indicated in the programme we have suggested for students in commerce could be given morning and evening, at suitable hours, by duly competent persons; and yearly examinations, presided over if not conducted by merchants of the first-class—as the leading solicitors and the members of the medical profession now conduct the examinations of the medical and law institutions—could be held, and certificates granted according to proficiency. It would be necessary for the successful conduct of such examinations, and to give students the opportunity of acquiring the requisite knowledge, that a Commercial Institution should be established, to be superintended by an able and influential executive.

The fees from students, on entry, for attending lectures, for the examinations, and for contributions to a library fund, would amply pay the expenses of such an institution.

It would be necessary, also, that a preliminary examination should take place of every student who enters himself for attendance at the lectures, or that he should bring a certificate from the school at which he has been educated of proficiency to a certain degree in the subjects proposed to be taught in the two years' courses at the institution.

It is not for us to show how the same plan and principles of action could be adopted for giving the higher grade of scientific instruction to the students in other branches of industry to which the attention of the sub-committee has been directed; but the Institute of Civil Engineers, the Institute of Architects, the Royal Agricultural Society, the Institute of Naval Architects,—might all make arrangements under which the large class of students who cannot remain at school or devote their time exclusively to educational pursuits after sixteen or eighteen years of age, might carry on their studies in the highest branches of scientific knowledge whilst actually engaged in learning the practical details of their profession. It is believed progress would be more satisfactory when obtained in this way, and be more thoroughly

impressed on the mind than when obtained in a college or in a separate educational institution, and that the pursuit of theoretical and practical knowledge during the same period would tend to greater proficiency in both than can be acquired by the present plan of education. But in all probability a course of two years, sufficient if the two years were devoted exclusively to study, would require three, or, in some cases, four years, to enable a student to pass the final examination if he were occupied in business.

In connection with such educational institutes, residences might be established for young men desirous to make the best use of their time, which, while bringing together a number of the more studious men, might conduce to good conduct and great economyof living.

D. Cooper.
Leone Levi.
W. Hawes.

The foregoing report was taken as read, having been previously circulated amongst the members of the Committee.

Mr. Ayrton, M.P., said that he had very carefully read the report which the Sub-Committee had presented, and which in itself was an ample reward for all the trouble that had been taken. It seemed to him that the fundamental proposition which the Sub-Committee had laid down tended very greatly to illustrate, in the first instance, the leading principles which must guide anyone in dealing with this question. Undoubtedly, when the question was taken up by that Committee it was involved in a great amount of confusion, and it was difficult to say what anyone intended when he spoke of a desire to promote "technical education" in this country. The first subject, therefore, which the Sub-Committee considered was, what was to be understood by the term "technical education." Their first decision was to eliminate from what was called technical education manual instruction in arts and manufactures given in the workshop, and this view, he thought, would commend itself to all those who had taken any interest in the subject. Undoubtedly there were some who took a different view, but he thought the more they studied the argument the more they would be induced to concur in the conclusion at which the Committee had arrived. It was no less satisfactory to see that the Committee had properly confined technical education to mean general instruction in those sciences the principles of which were applicable to the various employments in life. This proposition appeared to him to be invaluable in getting rid of those attempts that had been going on in so many educational institutions to cram children with a few interesting facts which they might repeat when they went home, and so appear very learned, whereas, in truth, they had learned these few facts without any clear appreciation of the principles upon which they depended, and therefore in after-life they were wholly incapable of applying any of these facts. He had himself seen many instances of that state of things. As director of a large railway company, he naturally met with many people who professed to be very well instructed, but it was generally rather in certain scientific facts than in the principles upon which those facts depended, and therefore, when they were placed in any new set of circumstances, and had to deal with new ideas, they were found rather endeavouring to proceed empirically upon the little experience they possessed, than to apply first principles to these new circumstances. This was really a serious defect in all branches of industry. It was a common observation, that if they wanted a man to go beyond the mere experience of what was going on around him, they must go either to France or Prussia to find such a man at any reasonable expense, because a knowledge of scientific principles was in England possessed by so few, except leading scientific men, whose services could not be obtained except at a very great expense. Where there was one in England there were twenty in France or Germany, who knew enough of scientific principles to be able to apply them to the common affairs of life. He considered, therefore, that the Sub-Committee had done great service, simply by endeavouring to fix public opinion upon the proposition he had referred to. It was of course in accordance with that view that they had come to the conclusion that technical instruction should not be given in separate scientific institutions, but in the existing schools; in other words, that the general principles of things should be taught, leaving to a subsequent stage the application of those general principles to particular courses of study more immediately connected with the profession or employment which might be ultimately selected. He very heartily appreciated what had been done by the Sub-Committee, and was very anxious that they should continue their labours in the same spirit. They had appended to their report several courses of study, which were recommended by the gentlemen whose names were attached thereto, and upon this appendix he should like to make one or two observations. One was that they all pointed at what might be called a final course, but they did not introduce that by a complementary preliminary course. Now it was quite clear that they would not attain the object they had in view, unless they had both, because one great evil under which they now suffered was that youths approached the scientific course too late in life, and with absolutely blank minds. They must bear in mind that in the larger class, and particularly the class which they were desiring especially to benefit, they could not expect their educational course to be carried on beyond the age of 17 or 18. The only way in which that difficulty could be met was by arranging that the scientific education should be begun so early as to be brought to a satisfactory end by the time when circumstances required that the young men should have finished their education. They could not get over this fact, that if the desired education was not given before the age of 17 or 18, it was not got at all. They would much prefer that education should go on longer, but as family exigencies generally prevented it, they must conform to what was inevitable. What had been the experience of centuries? What had been done with classical education? It had been asserted and acted upon for three hundred years, that a boy of eight years old could embark in a scientific study of considerable complication and considerable abstraction, viz., the study of grammar; that he could learn all the elementary rules of grammar; examine the construction of a sentence analytically; engage in the construction of sentences synthetically; consider general rules as applied to particular cases; and also examine particular cases as containing the elucidation of general rules. That was admitted to be practical with regard to two dead languages, which were now only symbols of ideas. If that could be done, and if that was the practice in all schools, why could not a boy be taught science in the same way? Again, they found that arithmetic was taught in schools to boys of seven years old, and this was one of the purest abstractions possible, for numbers, in the first instance, had no relation to definite ideas. A boy of ordinary intelligence, however, would be in the Rule of Three by the time he was eleven or twelve, and then he was pursuing the theory of numbers into abstract reasoning. How, then, could any one possibly undertake to say that they could not teach science in the same manner, and to the same extent? It had been asserted again and again that this could not be done, but the assertion was based upon no authority, and was contrary to all knowledge and experience. The first proposition, therefore, was, that if they wished to pursue a scientific education to its highest limit, they must begin early and ground well, and a boy must be as familiar with all the fundamental rules of material things, and to a large extent with their application, by the time he was

thirteen or fourteen, as he was now with the rules of Latin and Greek grammar, and with the application of those rules. He wanted the Sub-Committee to examine their appendix from that point of view, and so prepare for the the consideration of the educational world a scheme showing what was the best mode of approaching the study of science by children who intended to pursue that study to its highest limits, just as it had been considered what was the proper method of teaching those children who desired to become classical scholars, and who did become very sound scholars, in that branch of learning, by the age of eighteen. They need not be discouraged by the apathy which had hitherto been felt on this matter. There could not be a more striking fact than this, that classical education had been going on for three centuries, and it was only within the last two years that the masters of public schools had met together to consider whether their system of elementary teaching was a wise one, and had re-constructed, to a great extent, their elementary Latin primer. If the Committee would do the same thing, a great good would be accomplished. The next thing, then, would be, with regard to what might be called the secondary or higher course; of course many boys did not remain at school even until eighteen, and for their sakes it would be a grand thing to have a good elementary course which would prepare them for adding whatever higher knowledge they could obtain hereafter; but, with regard to the higher course, he did not think it would be satisfactory if they were to send out, as a final result of their labour, the seven different sets of ideas which appeared in the appendix; but he hoped they would settle some course of high scientific education which they could recommend. He had no doubt, looking to the names of the gentlemen attached to the report, and the admirable manner in which they had developed the three or four propositions to which he had directed attention, that if the Sub-Committee would only evolve a course of their own, and define that course accurately and clearly, they would achieve the only success and the only effective result they could hope to obtain—the general adoption of that course by the educational establishments of the country—that being obtained by the only authority they could exercise, the authority of public opinion based upon intelligence and reason. He held in his hand a book which would illustrate what he meant better than any further enlargement; a description of the course of study at the special school of Arts, Manufactures and Mines at Liège, which gave a detailed programme of the course of instruction. That was recognized in Belgium by Government authority as defining what was a proper course of study in scientific pursuits, and he thought that without the seal of a minister, but simply by the influence of opinion, the Sub-Committee might do as much for scientific instruction in England. Without going too much into detail they could set forth a course of study which would be intelligible to any schoolmaster, and which would enable him to guide the progress of his pupils. If they could lay down such a scheme as would be supported by public opinion, it would necessarily be adopted by those educational bodies which possessed the rewards of learning, and which of course exercised a very powerful influence over all educational establishments in the kingdom. He did not say they should produce so large a book as that which he held in his hand, but it would be necessary to go somewhat into detail, because if they did not clearly define what was meant, they would be liable to the charge of having given only a superficial consideration to the matter, and of concealing the difficulties which lay below the surface; and if this was once suspected, there would be an end to any idea of their moral ascendency. He hoped the Sub-Committee when they prepared a course, would be careful to avoid the grave error of confusing the species with the genus, or the only result would be an increase of difficulties. He did not say this by way of adverse criticism on what had been done, because he looked upon that as the first effort to approach the subject, and as done with a view to future consideration; but, on the contrary, he desired to express his cordial thanks to the Committee for what they had done, and, as he had said before, if they had done nothing but establish the first proposition contained in their report, they would have well earned the thanks of those by whom they were appointed. He hoped they would be encouraged to pursue their useful labours, and give the public a clear idea of what scientific instruction ought to be, and lay the foundation of a sound public opinion upon this important question, which was the first step towards attaining the object they had in view. He concluded by moving the adoption of the report.

Prof. VOELCKER thought it was worth consideration whether it would not be wise to leave out the appendix altogether. He fully agreed in all that had fallen from Mr. Ayrton; and, having read the report of the Sub-Committee very carefully, was perhaps qualified to give an opinion upon it. It appeared to him a very excellent report, and he had no doubt the public in general would regard it as such; but he thought perhaps the undefined and sketchy manner in which the scheme was put forward in the appendix might detract from its value. This, however, was a matter upon which those who had drawn up the report would probably be the best judges. He would impress upon those who were interested in this question the importance of introducing the elements of science into every description of school, whether it were a village school or a classical academy; the elements of natural science, more especially what were called the descriptive branches, might be taught to all grades of society. He did not see why a child at the age of five or six years could not be interested in what he saw around him, and taught by those very objects to obtain correct and definite ideas. He was sure that the elements of botany, as far as descriptive botany was concerned, might be taught to the children of labourers, and it would be equally useful to those who afterwards had the privilege of attaining to a higher kind of education. It was really marvellous to see sometimes highly educated members of society perfectly unacquainted with the first laws of natural science. They could not describe the different parts of a flower, and hardly knew the head from the tail of some animals. If their efforts were directed to the introduction of the elements of descriptive science into every kind of school, a very useful service would be done to the furtherance of technical education.

Professor WILLIAMSON, F.R.S., had listened with great interest to the thoughtful remarks of Mr. Ayrton. He thought it was of the greatest importance that attention should be drawn, above all things, to laying the foundation of a scientific education as early as possible, and by drawing special attention to that, Mr. Ayrton had seized hold of the difficulty with which those who attempted to organise any general system of scientific education would have to deal. At the same time he thought that those who had had most opportunities of observing what was done, and also the failures that had occurred, were keenly alive to the fact that at present the methods of instruction in elementary science were very imperfect. They really looked upon this as a problem which ought to be worked out—and certainly anything which could be done to accelerate the sound and solid realisation of a scheme of that kind was of pre-eminent importance—but the difficulties were so great, that he had himself always felt considerable hesitation in propounding any specific scheme. In the first place, he did not think it probable that any one absolutely uniform scheme would be adopted throughout all primary or secondary schools, but that considerable diversity of opinion was likely to prevail among even the better teachers of elementary mathematics, and the other branches of science, either pure or applied. It appeared to him that the usefulness of the work of this Committee might be somewhat diminished if instead of drawing attention mainly to

those things upon which they were all pretty well agreed, they were to venture much upon particulars which, however important, they were as yet less definitely agreed upon. For that reason, although he certainly felt that nothing could be so desirable as to put forward a specific scheme of elementary education in physical science, he was so strongly impressed with the difficulties of that problem, that he thought it better to be too slow rather than too fast in attacking it. With regard to the age up to which young men might be expected to pursue the study of pure science, irrespective of its ulterior application, the remarks of Mr. Ayrton were quite true. The great majority of young men would not go on beyond the age of 17 or so, but at the same time they must not shut their eyes to the fact that some did pursue their studies considerably longer, and did reap from that greater investment of time an advantage so important that he conceived it to be his duty to point it out to others who did not believe in the importance of remaining longer at college; for this higher instruction was in the main such as was given at college as contra-distinguished from school. He had seen the benefit of this for practical money-making purposes in a considerable number of cases, during his connection with University College for the last twenty years. There were a certain number of young men who, under his recommendation, had remained until the age of 22, or even longer, and who afterwards applied their knowledge to practical purposes, and he did not remember a case in which it had not paid admirably to do so. Such young men obtained such a power of dealing with everything relating to matter, that there arose quite a competition for their services; in fact, such men were rarely to be found, without seeking in Germany or elsewhere for them, not because an Englishman, if well educated, was not equal to any one; not because he was not even better, but because there were not enough of these educated men in this country. What he had said with regard to a special scheme for elementary education must be held to apply, to some extent, to the schemes of higher education, in which the Sub-Committee had gone into some particulars. Whether the words they had used were accurate or not was a question he would not enter upon, but he would merely say that, whilst admitting that physics was a word nearly synonymous with natural phenomena, and which properly included all natural phenomena, and admitting how undesirable it was that it should be limited to heat, light, electricity, and some branches of dynamics, it must still be admitted as a fact, that in a good many chairs of natural and experimental physics the word was thus understood. Chemistry, which of course denoted the study of a certain branch of science, was a branch of natural philosophy, but was not generally so regarded. For these reasons the Sub-Committee had purposely avoided going too much into particulars, but at the same time had endeavoured, as far as possible, to define in general terms such a course of study as would form a good preparation for a young man before devoting himself to any branch of manufactures. Still he quite agreed in the view that the sooner details could be worked out the better.

Dr. Storrar, as a member of the Sub-Committee, wished to say a few words in support of the view taken by the last speaker. He thought it one of their special merits that they had not ventured to define too distinctly the several subjects which should constitute a course of study in natural science, for it was utterly out of the question to suppose that a committee sitting in those rooms could exercise an omnipotent authority, even if it were omniscient, over the independent judgment of the professors of the physical sciences in the different universities. It was one great advantage in this country that there existed such an amount of diversity and elasticity in courses of study as were fitted to meet the wants of minds of various degrees of growth, and presenting a variety of peculiarities. If the Sub-Committee had ventured upon the course suggested by Mr. Ayrton, he thought they would immediately have had turn round upon them all the science faculties of the universities, asking by what authority a Sub-Committee of the Society of Arts could contemplate dictating to them how they should teach science. That view had been very strongly before the minds of some members of the Sub-Committee, and he confessed he thought they had gone quite as far as was desirable in even sketching out those courses in the appendix. He also agreed with Professor Williamson that if they wanted to cultivate science in this country with a view to its useful application to the arts, they must not contemplate education ceasing at the age of 17, they must not so readily accept the prejudices of society when they were so injurious. In the University of London young men could not take a science degree at an earlier age than 18, and many took it at 19 or 20; and it would be some encouragement to know that that University having had three of Mr. Whitworth's exhibitions assigned to it, actually one of their Bachelors of Science did not think it unbecoming in him to compete for one of these exhibitions. He thought it would be more conducive to the advancement of science honestly to say what they meant and to set up a high standard, rather than accept any crude notions which were entertained by the public, that they must have young men in business at the age of seventeen. He felt some little difficulty in joining issue with Mr. Ayrton on the subject of elementary science teaching. He did not doubt for a moment that it was of importance, and so strongly did the School Inquiry Commission feel upon this subject, that in their report they recommended the introduction of natural science into all classes of secondary schools. At the same time, it was all very well to sit in a room and think how very easy it was to introduce natural science into a school, but it was a very difficult thing to accomplish, and he did not see how it was to be done. Not having been engaged in teaching himself, he had taken some pains to ascertain how it could be done, and had lately visited Rugby and Harrow, the two public schools where most attention was paid to this branch of knowledge. He had no hesitation in saying that they devoted themselves most honestly to it; but, at the same time, the ablest teachers amongst them felt considerable perplexity as to the way in which it was to be effected. It was easy to teach children a mere knowledge of facts, to give them object-lessons, and at a certain stage of development to go a little higher, say in botany, and teach them the different parts of a flower and the principles of classification; he had seen a class of this kind at Rugby two months ago, each pupil having before him specimens of plants, a three-power microscope, and a syllabus of the natural orders of British plants; and they were being drilled in the best mode of differentiating out these plants, and assigning them to their proper natural orders. This was an admirable exercise, but, as far as he could make out, that kind of inductive faculty which enabled a youth to attack natural science with advantage was not of early growth, and he thought children could be taught a good many things before they could be taught science. Of course he felt the responsibility of so saying, and he said it with some diffidence, but so far as his own experience of the young mind was concerned, and so far as he had been able to ascertain from the experience of schools, he very much doubted if anything satisfactory in the way of teaching science, as science, could be done before the age of fifteen. He had not formed this opinion hastily, or without much consideration; and seeing what difficulties surrounded the question, although he was very anxious for the introduction of natural science into schools, and almost considered himself an apostle on the subject, he would not rashly interfere with linguistic institutions for the mere purpose of introducing instruction in things. The two departments of knowledge should proceed side by side, and, in due time, they would find their relative

places. He did not think any advantage would be gained by remitting this subject again to the Sub-Committee. The report now presented was the fruit of great labour and considerable time, and, for the reasons already given, he did not think, if they were to elaborate that report at greater length, it would produce any results which would further the object they had in view.

Dr. YATES, as a practical schoolmaster, could confirm almost everything which had fallen from Dr. Storrar. He had read the report repeatedly, and it seemed to him a most judicious one. As to what might be done in the way of teaching science to children of eight years of age, he would venture to give a little of his own experience. He was the son of a schoolmaster, and at 16 or 17 he went to Holland, and became a naturalised Dutchman, in order to pass through their schools for the purpose of learning how to teach. From there he went to Switzerland, and subsequently spent a considerable time in Leipzic and in Berlin. After ten or twelve years of careful preparation on the Continent, he came back, in 1851, to the neighbourhood of the Crystal Palace, determined to lend such aid as he could to the cause of scientific education. He began teaching science; and although himself possessed of some knowledge of chemistry, which he had studied at Edinburgh, he selected Mr. Galloway, one of the most eminent teachers of that science, now in the School of Industry at Dublin, to render him assistance in that department. He was most zealous in his profession, having a thorough love for it; and he associated himself with him (Dr. Yates) for three years, working in the kitchen, and making use of the kitchen furnace for his experiments. But, with all his endeavours, he could not make chemistry grow there, and he was obliged to take his talents elsewhere. Then Mr. William Crookes, now a fellow of the Royal Society, and a very able chemist, was good enough to try what he could do for 12 months, to see if chemistry could not be made to grow. But they could not create a demand for that which they brought into the market, and it was therefore useless to continue the effort. They must act first on the parents, and if they could create an improved public opinion, they might then hope to do something. Mr. Crookes was with him for 12 months, and it could not be said that during that time chemistry was not well taught; but out of more than 250 pupils which he then had, he could not say that more than one had become a chemist. He had tried very hard to introduce science teaching, but in a school of nearly 300 he did not find more than six or seven per cent. who would take to scientific pursuits. Since then he had found a difficulty in inducing persons to co-operate with him, and had been obliged to be content with imparting a certain amount of instruction in general science, sending his pupils to South Kensington afterwards for examination. What had beaten him was, in the first place, the great expense connected with having good science teachers; the labourer was worthy of his hire, but in the business of teaching the great difficulty was how to increase a man's emoluments in proportion to his value. The prospects of introducing science depended so much on circumstances that they could not lay down any definite plan; and although the teachers might be in earnest for some time at least, the money question would baffle their endeavours.

Mr. G. F. WILSON, F.R.S., said he would venture to call the attention of gentlemen who doubted the practicability of teaching science at a very early age, to the experience of Professor Henslow, in teaching botany to village children in Suffolk. Some years ago he had an opportunity of testing the real value of their knowledge, in this way. Being in Scotland, he found a flower which he knew none of the children could have seen, and he therefore sent it to the Professor, who returned to him the papers written by all the scholars in the first class upon it, which were wonderfully correct, showing that they had attained a very considerable knowledge of botany. This knowledge was of course useful to them in after-life, and, he might add, that it was considered in the neighbourhood that there were no such nursemaids to be had anywhere as the Professor's scholars.

Mr. E. A. DAVIDSON wished to add a word on the subject of elementary education, which formed the special theme of a paper read by him before the Society of Arts in December last. He did not mean for a moment to degrade science to such a point as to say that you could teach science positively to little children in national schools, but they could be prepared with elementary knowledge, and the crudities of their minds cleared away, so that when they reached a higher stage of education, the teacher under whom they might be placed would be free to do something towards teaching them real science, instead of having simply to clear away not only their natural roughnesses, but those caused by acquired ignorance, by positive mistakes of knowledge. Children were always learning something, and if they did not learn rightly they would learn erroneously, therefore the sooner they began to learn something correctly the better. But he thought there were great mistakes made as to what boys really could do. Having himself been engaged in teaching, as part of his occupation in connection with national schools, he had some thousands of boys per year pass under his eye, and he could mention many instances of boys, under the age of eight years, who had taken honours and prizes, under the Science and Art Department, in practical and plane geometry. Although some teachers might have crammed boys with some thirty or forty problems in plane geometry for the purpose of an examination, he could honestly say that he had never done such a thing, and it was therefore evident that a really sound knowledge of geometry and its application to a certain extent might be taught to boys at an early age. Then he would call attention for a moment to the Jewish schools. In the Jewish Free School in the City there were about 3,000 boys, and not a boy there but, if you opened a Hebrew Bible at any part, could read and translate it; when a boy of eight could do that with a dead language, acquired simply for the purpose of reading the Scriptures in the original, it was evident he was able to receive other teaching. The whole question, however, seemed to him stopped by a sentence which the Sub-Committee in their report had applied to one branch of study, but which he thought might with propriety be attached to all. The words used were "Mechanical or linear drawing must be taught to an extent for which even teachers would not at this moment be found." That was the grand difficulty. A man who was to teach properly, even elementary science, to teach it in such a manner as to interest children, must know a great deal more than the elements himself. The higher a man's knowledge was, provided he were possessed of aptitude for teaching, the better would he teach. The Science and Art Department certified a few men to go about as visiting teachers, but anyone acquainted with the practical business of teaching, must know that the man who came into a school for an hour or two in a week had but little influence over the children. If science were to be taught effectually, it must be by the master, who was with them every hour, who acquired a personal grasp of their minds, and who created a certain spirit of love amongst them. Therefore the teachers must be trained purposely, and the sciences, —especially what were called the applied sciences—must be efficiently taught in the training schools for national schoolmasters, so that when they went to a national school, however elementary the scientific knowledge which they imparted, it should at least be sound, and then the boys whom they taught, when they left school, would be much better qualified to learn the trades to which they were apprenticed, and would be at once instructed in them by their masters, instead of being left for a considerable period really in the position of errand-boys. He had been surprised to hear the age of 18 spoken of as the limit; he was connected with the scientific staff of the City Middle-class Schools, and he was sorry to say that they could rarely keep a boy beyond 15—very

often not so long,—but, even then, all who had left the school had positively taken positions distinctly because of the amount of knowledge they had acquired. They had sent out a considerable number this year much earlier than they wished, but the money consideration stepped in, and parents found there were openings which they felt compelled to take advantage of, and they could not keep them longer. But even in national schools, where the boys left at 12 or 13, such little scientific education as could be given would be of great service. Mr. Davidson concluded by narrating the difficulty he had experienced in getting a simple Bunsen's gas-burner made in London, having applied in vain at two shops, and succeeding at the third only when he undertook to cut out in paper the shape and size of the pieces of metal required, whereas a very slight knowledge of the principles of projection and solid geometry would have rendered the task perfectly easy to any workman. He should be happy to place at the disposal of the Sub-Committee the schemes of instruction which he had obtained from Darmstadt, Hanover, and Wurtemburg, when he was preparing his paper on technical education.

Mr. H. POOLEY, as representing the Liverpool Chamber of Commerce, wished to express his pleasure at being present, and at reading the comprehensive and valuable report which had been presented. He hoped the labours of the Committee would be pursued, which he believed would be of the greatest national advantage.

The CHAIRMAN said, if no one else had any remarks to offer, he would put the resolution for the adoption of the report which had been presented, but before doing so, he must give to the gentleman to whom they were mainly indebted for the report, Mr. Fleeming Jenkin, the credit which was his due. He (the chairman) had not been able to attend the more recent meetings of the Sub-Committee, but the earlier ones he had attended as regularly as he could, and he was sure they were all much indebted to Mr. Jenkin for his valuable services in so clearly apprehending, retaining, and embodying in the report the opinions of the Committee. It was a very difficult report to draw, for when they entered on their inquiry almost every variety of opinion was represented on the Sub-Committee, and it was not until the seventh or eighth meeting that their views began to take a definite shape. Mr. Jenkin then began to prepare a skeleton report which had since been elaborated with great patience and skill into the form in which it now appeared. In their discussion that morning they had certainly branched out a good deal, partly in reference to primary education, which was carefully excluded from all their discussions on the report, but that branch of the subject he hoped would come before them when they met later in the year, for having done so much, he could hardly believe the Committee would now stop short and say they would not enter into a consideration of the beginning and end of that course of instruction to the intermediate stage of which they had given so much attention. He quite agreed that they could not teach very young children pure science, but they could undoubtedly teach them to love science, and if they could do that it was much better than cramming them with a number of historical facts. Unless a child began to look into nature, and to appreciate its varied phenomena, to think what a thermometer or barometer was, to speculate on the causes and effects of thunder and lightning, there was very little chance of his being fond of science when he was fifteen, or when he got into the hard business of life. He always considered those children very fortunate who had parents or tutors, at an early age, who were fond of science. If this had not been his lot, he would have had no knowledge of it at all. It was his good fortune, at a very early age, to be associated with Mr. Joyce, whose "Scientific Dialogues" were well known, and to be constantly meeting Dr. Wollaston and several men of that class, and in that way he had imbibed a love of science which would last him his life. He had never been to school, and was put into business at the age of fourteen, and all he had learned since was in consequence of the taste which he had acquired at an early age.

Dr. STORRAR said children might be taught the facts of science, but when they came to science itself a more mature mind was required.

The CHAIRMAN said he would not discuss that question. There was no dispute that children might be taught, with great advantage, much of which they were now left in total ignorance, and this early training would be of great service to them hereafter. Perhaps some gentleman present would second the resolution for the adoption of the report.

Mr. ANTONIO BRADY had much pleasure in doing so. From his experience of elementary teaching, he feared the great difficulty would be to find masters competent to teach science, and so induce in children that love for it which would lead them to follow up their investigations. He could mention one instance, however, that of his friend Mr. Gilbert, who taught the children in the Plaistow Marshes so much botany that it became quite a rage. In national schools they did not so much want to teach science in its strict sense as to impart a taste for it, and this might very well be done. He had had many thousand children under his notice, but they could never keep them after 12, and many left at 11 years of age. It was quite plain that in such cases they could not teach science, but at the same time a good deal of elementary scientific knowledge might be imparted which would be very useful in after life. In conclusion, he hoped they would see the principles embodied in the report thoroughly carried out.

The resolution was then carried unanimously.

The CHAIRMAN then put successively resolutions that the Council be requested to print and circulate the report, and that the Sub-Committee be requested to continue their labours next session, which were both carried unanimously.

A vote of thanks to the Sub-Committee, for their valuable services in the preparation of the report, was then passed; and, in conclusion, a vote of thanks to the Chairman (Mr. Hawes) was passed by acclamation.

CANTOR LECTURES.

"ON FOOD." By DR. LETHEBY, M.A., M.B., &c.

LECTURE I., DELIVERED MONDAY, JANUARY 20.

Varieties of Food—their Chemical Composition and Nutritive Value.

(*Continued from page* 619.)

Maize or *Indian Corn* is one of the most extensively used grains in the world. It enters largely into the food of the inhabitants of America, Italy, Corsica, Spain, the south of France, and the Danubian Principalities. Since the famine in Ireland, it has there also become a common article of diet, especially when potatoes are dear; but its flavour is harsh and peculiar, and nothing but a scarcity of more agreeable food reconciles people to its use. The young grain called *cob*, is, however, more palatable, and forms, when boiled in milk, an American luxury, which takes the place of green peas.

The farina is peculiar when examined under the microscope, and will thus serve to recognise it.

Although the meal is rich in nitrogenous matter and fat, it does not make good bread. It is, therefore, either cooked by baking it into cakes, or by stirring it into boiling water, or boiling milk, as in the case of oatmeal, and thus making a sort of hasty-pudding, or thick porridge. This is the method of using it in Ireland, and it is flavoured with salt, or butter, or treacle. The favourite mess called *corn-lob* by the creoles of British Honduras, is prepared with milk in the same way. Indian meal mixed with maple sugar, and baked into

cakes, formed, at one time, the chief article of diet of the almost extinct Delaware Indians.

When deprived of its gluten, and harsh flavour, by means of a weak solution of caustic soda, and then dried, it forms the expensive food called *Oswego* or *corn flour*, which is now largely used for puddings.

Lastly, it is often mixed with wheaten-flour and baked into bread, but its harsh taste is never completely covered.

The grain is said to cause disease when eaten for a long time, and without other meal—the symptoms being a scaly eruption upon the hands, great prostration of the vital powers, and death after a year or so, with extreme emaciation. These effects have been frequently observed among the peasants of Italy, who use the meal as their chief food, but I am not aware of any such effects having been seen in Ireland, where it is often the only article of diet.

The nutritive power of Indian meal is very high, and, considering its price, it is almost, if not altogether, the cheapest food for the poor. Calculated according to the physiological wants of the system, a week's diet for an adult will only cost about 10½d., and excepting split-peas, which are of doubtful digestibility, there is nothing approaching it for economy.

Rice is the principal food of eastern and southern nations. It is extensively cultivated in India, China, South America, and the southern countries of Europe; and it gives nourishment to not less than a hundred millions of persons. In this country, however, it is rarely employed, except as an adjunct to other foods. Now and then, in times of scarcity, it is used in the place of potatoes. Perhaps 50 per cent. of our labouring classes use it in this manner. It is imported into this country in a decorticated or cleaned condition, but when it has the husk upon it, it is called *paddy*. The kinds which are most esteemed in this country are Carolina and Patna; but according to Dr. Watson, there are many Indian varieties which are nearly equal to the American. The proportion of gluten in it is only about 6·3 per cent., and it rarely exceeds 7. It is, in fact, one of the least nitrogenous of all the cereals, and cannot be made into bread, unless it is mixed with wheaten-flour, as is the custom in Paris, in making the best white bread. The proportion of nitrogenous to carbonaceous matter is as 1 to 12·7, or nearly twice the amount in wheat. It is, therefore, a good adjunct to highly plastic foods, as ox-liver, poultry, veal, and fish; with all of which it goes well, especially in the savoury form of *curry*. Boiled with milk also, and dressed with egg, as rice pudding, it forms a substantial meal; but in no country is it eaten alone.

The *Millets*, called also *Dhurra* or *Dhoora*, are another kind of grain, and are derived from many species of plants, as *sorghum*, *penicellaria*, *panicum*, &c. Like rice, they are extensively cultivated in India, Egypt, and the interior of Africa, where they are important articles of diet. They are a little more nutritious than rice: for they contain, on an average, about 9 per cent. of nitrogenous matter, with 74 of starch and sugar, 2·6 of fat, and 2·3 of mineral matter. We have no experience of their nutritive properties in this country, except in feeding birds; but in India the grains are ground whole and made into bread.

The last of the grains of any importance is *Quinoa*, a species of *chenopodium*. It is hardly known in this country, although it is extensively cultivated and consumed on the high table-lands of Chili and Peru. Mr Johnston has described it, and he says there are two varieties of it—the sweet and bitter—both of which grow at an elevation of 13,000 feet above the level of the sea, where barley and rye refuse to ripen. It is very nutritious, and approaches oatmeal in its chemical composition, the amount of gluten being about 19 per cent., the starch and sugar 60 per cent., and the fat 5.

The next class of farinaceous foods are the *pulses*, as *peas*, *beans*, and *lentils* of this country, and the *dholls* and *grams* of India. They are grown and eaten in all parts of the world, and are everywhere regarded as very nutritious when they can be digested. Nothing, however, but the most prolonged cooking will serve to help in this particular. As will be seen by reference to the tables, where the composition of peas, the type of all of them, is given, they are rich in nitrogenous matter, for peas and beans contain about 23 per cent., and lentils about 25; but the carbonaceous constituents amount to only 59 per cent., or 1 to 2½. They are therefore, when eaten, invariably associated with fat. In India, the favourite pea (*cajanus Indicus*) is rubbed with oil before it is cooked. In Yucatan, and throughout the whole of Central America, where black beans, called *frijoles*, are extensively used as food, they are well boiled in water, and eaten with pepper, salt, and pork. In this country, butter with peas, and fat bacon with beans, are inseparable companions. Lastly, revalenta or ground lentils with cocoa, which contains over 50 per cent. of fat, are mixed in a well-known fancy preparation. The nitrogenous matter of the pulses is not of the nature of gluten, but is more like casein, or the cheesy matter of milk, and it was named by Braconnot, its discoverer, *Legumine*.

Other farinaceous foods, of little importance to us, are the meal of the *edible chesnut*, which is largely used by the peasants of Lombardy; the *Manioc* and *Lotsa meal*, which, Dr. Livingstone says, are the chief vegetable foods of the natives of some parts of South Africa; perhaps, also, the *horse-chesnut* and the *acorn* might be added to the list, for there is hope of their being easily freed from the bitter principle which now renders them useless.

And last of this class of foods are the *starches* and *arrow-roots*, which are largely imported or prepared in this country. They are *Bermuda*, *Jamaica*, or *West Indian arrow-roots*, from *maranta arundinacea; East Indian arrowroot*, from various species of *curcuma; Tous-les-mois*, from *canna; Brazilian arrowroot*, from *jatropha manihot*, which, when dried and partially cooked on hot plates, makes *tapioca;* and which, when baked in its whole condition, forms *cassava* bread; *sago* and *sago-meal*, from the fruit of various species of *sagus; Tahiti arrow-root*, from a *tacca; Portland arrowroot*, from the tubers of an *arum;* and *English arrowroot* from *potatoes*. All these are obtained in the same way—namely, by crushing, or bruising, or rasping the root or other substance containing them, and after diffusing through water, allowing the starch or fæculoid matter to deposit; it is then collected on a cloth and dried. In this country, starches are obtained by soaking the grain in an alkaline liquor, which dissolves the gluten, and then crushing between mills, straining to keep back the husk and cellulose, and then washing with water, and allowing the starch to subside. By this method of manufacture a quantity of gluten is obtained, which can be set free from the alkali by an acid, and collected for food.

All the starches and arrowroots are known by their microscopic characters; and although they have the same chemical composition and nutritive value, yet they are very different in their digestibility, for the true arrow-roots of the West Indies, as Bermuda and Jamaica, will often remain on the stomach of an invalid when the others will be rejected.

They contain no nitrogen, or but a trace of it, and therefore have no nitrogenous value, but they are useful for their carbonaceous properties; and they are best cooked by stirring them into boiling water or boiling milk, and then simmering for a minute or so.

The next class of vegetable foods are those which contain much water, and which may be called *succulent vegetable foods*, of which the *potato* is the most important.

Brought to us from America, in the seventeenth century, as a rarity, by Sir Walter Raleigh, it has gradually become an almost universal article of diet; for its advantages are so numerous that it will ever be a favourite food. It is, for example, easily cultivated, easily kept, easily cooked, and easily digested; besides

which it requires but little flavouring matter, and never wearies the palate. It is therefore used in times of plenty by all classes of persons, and is often eaten in quantities that approach very nearly to the rice allowance of a hungry Hindoo. "In Ireland," says Dr. Edward Smith, "when the season arrives and potatoes are plentiful, as much as 3½lbs. are consumed three times in a day by an adult. This, indeed, is the regular allowance, and an Irishman finds no difficulty in consuming his rations of 10½lbs. of potatoes daily." In England, the farm labourer consumes, on an average, hardly as much in a week. In Anglesea, however, potatoes are eaten twice a day, and the consumption is about 16½lbs. per adult weekly; and in Scotland the average allowance is 15lbs. per head weekly.

The nutritive value of the potato is not great, for, in the first place, it contains only about 25 per cent. of solid matter, and of this hardly 2·1 is nitrogenous. Potatoes are also deficient of fat, and therefore they require admixture with nourishing materials. They go well with meat and fish, and are considerably helped with a little dripping or butter; but the great adjunct is milk. In Ireland, potatoes and buttermilk are the principal diet, even in times of plenty.

Considering the cheapness of potatoes, they are a most economical food. At the price of a halfpenny a pound, as set down in table No. 4, it costs but two shillings and threepence a week to provide the carbon and nitrogen required by an adult; but when potatoes are cultivated upon cottage ground, by wife and children, as is the practice almost everywhere, as much as seven pounds can be easily obtained for a penny, and then the weekly diet would be rather less than eight-pence. At this price no vegetable food can compete with it.

Potatoes are best cooked in their skins, for the waste is then only about three per cent., or half an ounce in a pound; whereas, if they are peeled first, it is not less than 14 per cent., or from two to three ounces in a pound. The mealy varieties are more digestible than the close and waxy; in fact, when they are in this state, as is the case with new potatoes, and potatoes late in the season, which have begun to grow, they are best cooked by stewing them.

All succulent vegetables are endowed with anti-scorbutic powers, but potatoes are especially renowned for this property. As far back as the year 1781, Sir Gilbert Blane, in his work on the "Diseases of the Fleet," alluded to the beneficial action of the potato in scurvy, and from that time to the present, its salutary powers have been repeatedly observed. The late Dr. Baly remarked, in his inquiries into the diseases of prisoners, that wherever potatoes were used scurvy was unknown; and it is the almost universal practice now to carry potatoes, fresh or preserved, in all ocean-going vessels, with the view of preventing scurvy.

Other succulent vegetables in common use, as *turnips, parsnips, carrots, artichokes, onions, leeks, cauliflower, cabbages*, and *greens*, have, among themselves, nearly the same nutritive value, but they are all much less nutritious than the potato, as will be seen by reference to the Table No. 3; in fact, they do not contain more than from 9 to 17 per cent. of solid matter, and of this only about 1·2 is nitrogenous. They are chiefly valuable for their anti-scorbutic properties, and for their quality of flavouring insipid food, and diluting strong ones.

Banana and *bread-fruit* are also valuable esculent foods, and are largely used in the tropics. The former contains about 27 per cent. of solid matter, of nearly the same nutritive value as rice. About 6½ lbs. of the fresh fruit, or 2 lbs. of the dry meal, with a quarter of a pound of salt meat or fish, is a common allowance for a labourer. The *bread-fruit* is largely eaten by the natives of the Indian Archipelago, and of the Islands of the South Sea. There are several varieties of it which come into season at different times. It is very juicy, containing about 80 per cent. of water, and is generally gathered before it is ripe, when the starch is in a mealy condition, and has not undergone change into sugar. The fresh fruit is cooked, by peeling it, wrapping it in leaves, and baking it between hot stones. It then tastes like sweet bread; but much of the ripe fruit is preserved by peeling it, cutting it into slices, and packing it very closely in pits in the ground, made water-light, and lined with banana leaves. After a while it undergoes a sort of fermentation, or, as we should call it from the smell, putrefaction, and the fruit settles into a mass, of the consistence of soft cheese. When it is required for use, it is well kneaded, wrapped in leaves, and baked, like the fresh fruit, between hot stones.

Ripe fruits, as *apples, pears, peaches, pine-apples, oranges*, &c., are not of much nutritive value, for they rarely contain above 13 per cent. of solid matter, and this is of no more value than so much rice, but they have agreeable flavours, and serve the purpose of anti-scorbutic drinks.

Marine Algæ.—Everywhere along our coasts, there is abundance of comparatively nutritious food, which may, by a little management, be made palatable. I allude to our *sea-weeds;* and this Society has distinguished itself by its efforts to utilize this stock of now almost profitless food. Judging from the analysis of Dr. Davy and Dr. Apjohn, of Dublin, it would seem that when in a moderately dry condition sea-weeds contain from 18 to 26 per cent. of water; and that the nitrogenous constituents amount to from 9½ to 15 per cent., while the starchy matter and sugar average about 66 per cent. These results place sea-weeds among the most nutritrious of vegetable substances; in fact they are richer in nitrogenous matter than oatmeal or Indian corn.

The varieties of sea-weed at present used are the following:—

Porphyra laciniata and *vulgaris*, called *laver* in England, *stoke* in Ireland, and *slouk* in Scotland.

Chondrus crispus, called *carrageen* or *Irish moss*, and also *pearl-moss*.

Laminaria digitata, known as *sea girdle* in England, *tangle* in Scotland, and *red-ware* in the Orkneys; and *laminaria saccharina alaria esculenta* or *bladder-lock*, called also *hen-ware* and *honey-ware* by the Scotch.

Ulva latissima or *green laver.*—*Rhodomenia palmata*, or *dulse* of Scotland.—These, with many others, are eaten by the coast inhabitants of this country and the Continent. In some parts of Scotland and Ireland they form a considerable portion of the diet of the poor.

To prepare them for food, they should first be steeped in water to remove saline matter; and in some cases a little carbonate of soda added to the water will remove the bitterness. They are then stewed in water or milk until they are tender and mucilaginous; and they are best flavoured with pepper and vinegar. Under the name of *marine sauce*, the lavers were once a luxury in London.

As to the last of the vegetable foods—namely, the *fungi* or *mushrooms*—I have but little to say; for although the edible varieties are highly nutritious, yet they can never become an important article of diet. Most of them are employed at the present time as flavouring agents; and among these are the *common mushroom* for ketchup, the *morel* for gravies, and the *truffle* for turkeys and the livers of geese (*Pâté de foie gras*).

Sugar and *Treacle.*—Both of these are very generally consumed on account of their flavouring and fattening qualities Dr. Edward Smith found that 98 per cent. of indoor operatives partook of sugar, to the extent of 7½ ozs. per adult, weekly. 96 per cent. of Scotch labourers use it, and 80 per cent. of Irish. In Wales, also, it is commonly used to an average extent of 6 ozs. per adult weekly; but there is a marked difference in the rate of consumption in the northern and southern portions of the country. In North Wales, for example, the average amount per head is 11¼ ozs.; whereas, in South Wales it is only 3 ozs. The principle use of it is to sweeten tea.

Treacle has more flavour than sugar, and it is also cheaper. It is, therefore, more largely employed; and that description of it properly called *mollasses*, which

is the draining from the raw or unrefined sugar—treacle being the drainings from refined sugar,—is preferred on account of its stronger flavour, and is most usually sold for treacle. They go well with all descriptions of farinaceous food, as porridge, pudding, dumpling and bread.

Sugar contains from 4 to 10 per cent. of moisture, and treacle about 23. The rest is carbonaceous matter, without nitrogen. They are, therefore, heat-producing and fattening agents, and their power, in these respects, is about the same as with starch. Whether they can produce disease when used in excess is a matter of doubt; but Dr. Richardson declares that they cause blindness by creating opacity of the lens (*cataract*).

Animal Foods—First on the list of these is *milk*, a liquid which contains all the elements of food required by the very young, and is therefore regarded as the type or standard of food.

In some countries, as Switzerland, it is the chief diet of the peasantry; and everywhere, if easily obtained, it is largely consumed. 76 per cent. of the labouring classes of England make use of it; 83 per cent. take it as butter-milk; and 53 per cent. as skimmed-milk. In Wales, the average consumption of it by farm labourers is $4\frac{1}{4}$ pints per adult weekly—South Wales averaging only 3 pints, while in North Wales it is $7\frac{1}{2}$. In Scotland the consumption among the labouring classes is still larger, for it amounts to $6\frac{1}{4}$ pints per head weekly, and in Ireland it reaches $6\frac{3}{4}$ pints. Those who take least of it are the poor in-door operatives of London; the weavers of Spitalfields, for example, use only about 7·6 oz. per head weekly, and those of Bethnal-green only a fraction above $1\frac{1}{2}$ ozs. per head. When examined under the microscope, milk is found to consist of myriads of little globules of butter floating in a clear liquid. On standing for a few hours the oily particles rise to the surface and form a cream, the proportion of which is the test of quality. Cows'-milk is heavier than water in the proportion of from 1,030 or 1,032 to 1,000. Asses' milk is the lightest, for its gravity is only about 1,019; then comes human milk, 1,020; and, lastly, goat and ewes' milk, which is the heaviest of all, from 1,035 to 1,042.

The quality of milk varies with the breed of the cow, the nature of its food, and the time of milking, for afternoon milk is always richer than morning, and the last drawn than the first. Taking, however, the average of a large number of samples, it may be said that cows' milk contains 14 per cent. of solid matter, 4·1 of which are casein, 5·2 sugar, 3·9 butter, and 0·8 saline matter. The relations of nitrogenous to the carbonaceous is 1 to 2·2; but as fat is $2\frac{1}{2}$ times more powerful than starch, the relation may be said to be as 1 to 3·6.

When milk is heated to the boiling temperature, the casein is coagulated to some extent; and if the milk has stood before it is heated, so that the cream may rise, the coagulum includes the cream, and makes the so-called Devonshire or *clotted cream*.

Acids also coagulate the casein, and produce a curd, as in the making of cheese and curds and whey.

Cream is rich in butter, as will be seen by reference to Table No. 3. It contains 34 per cent. of solid matter, 26·7 of which are butter, and its gravity is about 1,013.

Skim-milk is the milk from which the cream has been removed. It contains only about half as much butter as new milk, and its gravity is about 1,037. In all other respects it is similar to new milk.

Buttermilk is the residue of the milk or cream from which the butter has been removed by churning. It is still poorer in fat than skim-milk, containing, in fact, only about half as much. Unless it is very fresh, it is generally a little acid, and frequently the acidity has gone so far as to set the milk into a kind of jelly.

The *whey* of milk is the opalescent liquor from which the curd has been removed in making cheese. Although not highly nutritious, it still holds a little casein in solution, as well as the sugar and saline matter of the milk. It is rarely used as food by the poor, but is given to pigs. In Switzerland, however, it is considered to have medicinal virtues, especially for the cure of chronic disorders of the abdominal organs, and the treatment, which is somewhat fashionable, goes by the name of *cure de petit lait*. There is a popular notion, that the whey of milk is sudorific, and hence we have our *wine whey*, *cream of tartar whey*, *alum whey*, *tamarand whey*, &c., when the milk has been curdled by these several substances.

Cheese is the coagulated product of milk, obtained by the addition of rennet or a little vinegar. When cream is coagulated it makes *cream cheese*, which will hardly bear keeping, but must be eaten fresh. It contains about half its weight of butter, and a fifth of its weight only of curd.

When cream is added to new milk, and the mixture is curdled, it forms very rich cheese, as *double Gloucester* and *Stilton*.

When new milk alone is used the cheese is less rich, but still of high quality, as *Cheddar*.

When an eighth or a tenth of the cream has been taken off, it produces the quality of cheese which is most sought after, as single Gloucester, Chester, American, &c.

And when all the cream has been removed, and the skim-milk is curdled, it forms the poor cheese of Holland, Friesland, Suffolk, Somersetshire, and South Wales.

At first every variety of cheese is soft and comparatively tasteless, but by keeping they undergo change, and develop their flavours, when they are said to be ripe.

Analyses of two of the most important of them are shown on Table No. 3, and it will be noticed that they contain from 56 to 64 per cent. of solid matter, about half of which is curd. In skim-milk cheese the curd amounts to 44·8 per cent., and the fat to only 3·6; whereas, in Cheddar, the curd is only 28·4 per cent., and the fat 31·1. In nutritive power, therefore, especially in nitrogenous matter, cheese ranks high, and is a valuable article of diet; but there is a limit to its digestibility, and hence it cannot be taken in large quantity. Considering its price also, it is hardly so profitable as many other foods; although, where good skim-milk cheese can be purchased at from $2\frac{1}{2}$d. to 3d. a pound it forms, in small quantities at a time, a good adjunct to bread.

Meat.—There is hardly a class of individuals, however poor, who do not make a strong effort to obtain meat. It would seem, therefore, to be a necessary article of diet. In this metropolis the indoor operatives eat it to the extent of 14·8 ozs. per adult weekly; 70 per cent. of English farm labourers consume it, and to the extent of 16 ozs. per man weekly; 60 per cent. of the Scotch; 30 of the Welsh; and 20 of the Irish. The Scotch, probably, have a larger allowance than the English, considering that braxy-mutton is the perquisite of the Scotch labourer; but the Welsh have only an average amount of $2\frac{1}{2}$ ozs. per adult weekly; and the Irish allowance is still less.

It is difficult to obtain accurate returns of the quantity of meat consumed in London; but if the computation of Dr. Wynter be correct, it is not less than $30\frac{3}{4}$ ozs. per head weekly, or about $4\frac{1}{2}$ ozs. per day for every man, woman, and child. In Paris, according to M. Armand Husson, who has carefully collected the *octroi* returns, it is rather more than 49 ozs. per head weekly, or just 7 ozs. a-day. We are not, therefore, such large meat-eaters as the French.

Butchers' meat differs very much in nutritive value according to the proportions of fat and lean; and there is a strong prejudice in favour of beef as the strongest kind of meat. In reality, however, the lean of all meat is of nearly the same nutritive power, provided it is digested; but in this respect there are large differences. The flavour also varies with the nature of the animal, and with its mode of feeding. Pampas-pig, and indeed most wild swine, are horribly rank, but by proper feeding they become delicious. In store animals, the proportion of lean is always greater than the fat, and the solid matter does not amount to more than 28 or 29 per cent.; not so, however, in fat animals, for then the fat is largely

in excess of the lean, and the solid matters make up about half the total weight. The tendency, indeed, of the fattening process is to substitute fat for water in the carcass; and the quality of the meat depends on the intimate intermixture of fat with the muscular tissue. All animals are not alike in their method of depositing fat, for some put it upon the surface of the body, and others accumulate it among the viscera. The art of breeding and feeding stock is to overcome both of these tendencies, and, at the same time, to produce a fat which will not melt or boil away in cooking. Oily foods have always a tendency to make soft fat.

The average proportions of fat and lean in the offal and carcases of animals are shown in Table No. 6

TABLE VI.—PERCENTAGE PROPORTIONS AND NUTRITIVE VALUE OF THE CARCASS AND OFFAL.

	In Animal.		Water.		Nitrogenous.		Fat.		Salts.	
	Carcass.	Offal.	Carcass.	Offal.	Carcass.	Offal.	Carcass.	Offal.	Carcass.	Offal.
Store Oxen	59·3	38·9	60·8	—	18·0	—	16·0	—	5·2	—
Half Fat do.	—	—	54·0	59·6	17·8	20·6	22·6	15·7	5·6	4·1
Fat do.	59·8	38·5	45·6	52·8	15·0	17·5	34·8	26·3	4·6	3·4
Fat Heifers	55·6	41·3	—	—	—	—	—	—	—	—
Fat Calves	63·1	33·5	62·3	64·9	16·6	17·1	16·6	14·6	4·5	3·4
Store Sheep	53·4	45·6	57·3	63·7	14·5	18·0	23·8	16·1	4·4	2·2
Half Fat do.	59·0	40·5	49·7	61·1	14·9	17·7	31·3	18·5	4·1	2·7
Fat do.	—	—	39·7	55·2	11·5	16·1	45·4	26·4	3·5	2·3
Very Fat do.	64·1	35·8	33·0	45·1	9·1	16·8	55·1	34·5	2·8	3·6
Fat Lambs	—	—	48·6	58·5	10·9	18·9	36·9	20·1	3·6	2·5
Store Pigs	79·3	18·8	55·3	67·9	14·0	14·0	28·1	15·0	2·6	3·1
Fat do.	83·4	16·1	38·6	59·4	10·5	14·8	49·5	22·8	1·4	3·0
Mean of all	64·1	34·3	48·4	53·8	13·5	17·2	34·4	21·0	3·7	3·0

and Table No. 3 (p. 616) exhibits the proportion of the principal nutritive constituents in ordinary joints of meat. Lean meat is evidently deficient of carbonaceous matter, and this is best supplied in bread or potato; but in fat meat, considering that the nutritive power of fat is twice and a half as great as that of starch or sugar, the carbonaceous matter is often in excess of the right proportion; it is remarkably so in pork, which will bear dilution with the flesh of rabit, poultry, and veal.

The amount of bone in meat varies: it is rarely less than 8 per cent. In the neck and brisket of beef it is about 10 per cent., and in shins and legs of beef it amounts to one-third, or even half the total weight. The most economical parts are the round and thick flank, then the brisket and sticking-piece, and lastly the leg. In the case of mutton and pork, the leg is most profitable, and then the shoulder.

Horse-flesh is hardly known in this country, except as canine food; but on the Continent, and especially in Germany, Belgium, and Swizterland, it is regularly sold in the public markets, and is considered by many persons superior to beef. Possibly we have often eaten it on the Continent without knowing it. A *Châteaubriand*, or double beef-steak of Paris, is said to be best of horse-flesh; and no doubt the frequenters of the *restaurants* of Paris have unwittingly acquired a fondness for it, and have relished it as good beef. A story is told by a writer in the *Saturday Review* of a Frenchman who blandly remonstrated with an Englishman for his scorn of French beef. "I have," he said, "been two times in England, but I navère find the bif supérieur to ours. I find it vary conveenient that they bring it you on little pieces of stick, for one penny, but I do not find the bif supérieur." "Good heavens!" cried the Englishman, red with astonishment, "you have been eating cat's-meat." To be serious, however, I do not see why the flesh of healthy horses should not be used as human food. It has indeed many powerful advocates, among whom is the great naturalist, Geoffroy St. Hilaire.

Venison and the dark flesh of other wild animals differs from butchers' meat in the circumstance that it is leaner, and that it contains more blood; but its nutritive power, when properly cooked, is not inferior to that of beef or mutton, and it is always more digestible.

The offal of meat constitutes about one-third of the entire weight of the slaughtered animal. It consists of the blood, the head and its contents, the tongue and brain, the heart and lungs, the abdominal viscera—as the diaphragm, the liver, spleen, pancreas, stomach, intestines, and reproductive organs, the feet, tail and skin. In the case of the pig, the skin and head are parts of the carcass.

Nearly all these, when properly treated, are good for food. The *blood* of the pig is mixed with groats and fat, and converted into *black-pudding*, which contains about 11 per cent. of nitrogenous matter. The *stomach* of the bullock is cleaned and boiled for *tripe*, which contains 13 per cent. of albumen and 16 of fat. The *heart*, *lungs*, and *pancreas*, which constitute about seven per cent. of the live weight of animals, are as nutritious as lean meat. The *head*, especially of the ox, makes good soup; but it requires long boiling to extract the nutriment. Boiled for eight or nine hours it will yield one-fourth of its weight of gelatine; besides which an ox-cheek will furnish about 4lbs. of good meat. Bones also contain much fat and nitrogenous matter, which they give up when broken small and boiled for many hours. Six pounds of bones are equal to one of meat for nitrogen, and to nearly two pounds of meat for carbon.

Bacon differs from fresh meat in the relatively large amount of fat and small proportion of water. It is an almost universal article of diet among the labouring classes. Seventy-four per cent. of farm-servants use it to the extent of from ¼lb. to 2lbs. per adult weekly. Sixty-nine per cent. of the Scotch use it, and 40 per cent. of the Irish. It is perferred to butchers' meat for many reasons—as that it goes further, especially with children, who don't generally like fat; it has more relish; it is easily cooked, and suffers less waste in cooking; besides which it is easily kept, and is always handy. Preference is nearly always given to the English bacon, notwithstanding that it is double the price of American, for the flavour is better, and it does not boil away in cooking. No doubt the inferiority of American bacon

is due to the method of feeding the pigs, for they run wild and eat large quantities of acorns and oily nuts. Good bacon should not lose more than from 10 to 15 per cent. in cooking.

The nutritive value of both green and dried bacon are shown in Table III. and Table IV. Their peculiarity is the large amount of carbonaceous matter they contain as compared with nitrogenous. Calculated as starch, it is as 20 or 24 to 1. Hence it is that it will improve the value of substances rich in nitrogen, as eggs, veal, poultry, beans, and peas.

Poultry and the *white meat* of *rabbits* are not of themselves very nourishing. They contain too much nitrogenous matter and too little fat. In the case of aquatic birds, as the goose and duck, the fat is more abundant; but in contains certain flavouring matters which are not easy of digestion. The darker flesh of game is also somewhat indigestible, and requires management in its culinary treatment.

Fish is not a favourite article of diet with the labouring classes, unless it is salted or smoked, and then it is chiefly used for its flavouring qualities. There is a prejudice that is has no nutritive strength, and it arises, perhaps, from the circumstance that it does not easily satisfy hunger, and is quickly digested, but the inhabitants of our coasts use it largely as food.

The nutritive value of the white varieties of fish, as *whiting*, *cod*, *haddock*, *sole*, *plaice*, *flounder*, and *turbot*, are shown in the Tables No. 3 and No. 4, and it will be remarked that they contain only about 22 per cent. of solid matter—18 of which is nitrogenous. They want butter, therefore, to increase their nutritive value.

Mackerel, *eels*, and *salmon*, are, however, richer in fat, for the former contains about 7 per cent. and the latter 6, while the oily matter of eels amounts to nearly 14 per cent. The same is the case with the *sprat*, the *herring*, and the *pilchard*, and with most of our fresh-water fish.

All fish are in their best condition at the time of the ripening of the milt and roe, for not only are they fatter at that time, but when cooked they have a better flavour, and the flesh is solid and opaque. On the other hand, when they are out of condition the flesh is semi-gelatinous and watery.

Shell-fish of all descriptions have nearly the same nutritive values. They contain about 13 parts of solid matter in the hundred, and this has the composition of white fish. Their digestibility varies—*mussels*, *limpets*, and *whelks* being rather hard of digestion, while, *scallops*, *cockles*, *periwinkles*, *lobsters*, and *crabs* are, perhaps, a little more easily digested, and *oysters* still more so. None of them are suited for delicate stomachs, although the poorer inhabitants on the coast eat them freely; and vinyard snail on the Continent, and even *slugs* in China, have a reputation for delicacy and nutritive power.

Eggs contain about 26 per cent. of solid matter, 14 of which is nitrogenous, and 10½ carbonaceous or fatty. The *yolk* is the part which contains the fat, for it there amounts to 31 per cent., while the *white* of the egg, which is entirely free from fat, is the richest in nitrogen —the albumen amounting to 20·4 per cent. Altogether, however, eggs are very deficient of carbonaceous matter, for, calculated as starch, it is only in the proportion of 1·75. to one of nitrogenous. Hence it is that eggs consort well with oil in salads, with fat bacon, and with all kinds of farinaceous matters in puddings.

Fat of some descriptions, as *butter*, *lard*, *suet*, or *dripping*, is universally consumed. In many cases it exists in sufficient quantity in the food, as in bacon and fat meat, but when this is not the case, it is invariably supplied from some other source. 99 per cent. of farm labourers use fat of some sort—butter or dripping, to the extent of 5½ ozs. weekly per adult. It is difficult to say how much is really required by the human system, but looking at the proportion in milk, it would seem to be not less than 28 per cent. of the dry solid food. The fats in common use contain about 80 per cent. of real fatty matter, the rest being water and salt, and although butter is the fat ordinarily purchased, yet dripping is equally valuable, and so also are the vegetable fats of the tropics. *Cocoa* and *chocolate* owe their chief value as foods to the fat they contain. Cocoa is composed of 50 per cent. of solid fat, called cocoa butter, and chocolate is a sweet preparation of it.

Of liquid articles of diet, *beer* and *porter* stand first in nutritive value. They contain about 9 per cent. of solid matter, 8¾ of which are sugar and gum. Their nutritive power is not, therefore, great; and yet, according to Liebig, whenever beer and porter are not used, there is always a larger consumption of bread.

The nutritive functions of *tea* and *coffee* are hardly understood; for although they are largely used, and as if by an instinctive craving, yet their actual nourishing power is insignificant. I shall deal further with this subject hereafter.

The last constituent of food that we have to consider is saline matter. Broadly, it may be stated that we require *phosphates* and *sulphates* of *potash*, *lime* and *magnesia*, and that we also want a still larger porportion of *common salt*. In most cases the phosphates and sulphates are in sufficient quantity in ordinary foods; in fact, Mr. Lawes found in his experiments on the fattening of animals that for every single part of saline matter retained in the system of the pig, there were from 14 to 15 parts in the food; not that the whole of this was lost, for probably it performed important functions in the processes of assimilation and secretion. Common salt, however, is not present in the food to any large extent, and therefore it must be added to it.

And now, before leaving this part of the subject, let us pause to consider the vast machinery which is in operation for the supply of food to this metropolis. At the present time over three millions of people have to be fed daily; and yet so regular is the supply, that no one considers even the possibility of its failing. On the other hand, there is no redundancy; and not only does this supply regularly reach the metropolis, but it is distributed to our very doors. About 4,200 tons of fish; over 4,000 sheep; nearly 700 oxen; about 90 calves; 4,000 pigs, including bacon and hams; not less than 5,000 fowls, and other kinds of poultry; besides a million or so of oysters; and eggs innumerable, with flour enough to make nearly a million quartern loaves; and vegetables, butter, and beer in proportion, are daily brought to this city. "Imagine," as Archbishop Whateley says, "a Head Commissioner entrusted with the office of furnishing all these things regularly to the people. How would he succeed?" And yet all this goes on with the regularity and precision of a machine —without Government or even municipal interference, but simply through the magical power and unfettered action of free-trade.

The lecture was profusely illustrated with specimens of foods from the collection in the Economic Museum of Mr. Twining, who kindly lent them for the occasion.

Fine Arts.

A FRENCH VIEW OF THE ROYAL ACADEMY EXHIBITION.—A correspondent of the *Moniteur des Arts*, of Paris, notices the exhibition in Trafalgar-square in the following severe terms:—"It has been this year, as it always is, the most deplorable thing in the world, as regards organisation and arrangement; if French artists could visit it, the sight of those pictures heaped together without logic or taste, from floor to ceiling, in a series of small, ill-lighted rooms, would cure them for ever of ineffective criticism respecting the Palais de l'Industrie in the Champs Elysées, which is a perfect museum in comparison with the hole in Trafalgar-square, to say nothing of the egotism of the English academicians. According to the precept that 'charity begins at home,' their first care is to secure for themselves the best places.

After them the Deluge! As to foreign artists, they are banished to the background, pushed into dark corners where the eye of a visitor scarcely ever falls upon their works. The artist world of London still echoes the scandal which occurred two years ago, when an admirable landscape by Daubigny was placed up in the roof. A simple act of courtesy on the part of the committee is so extraordinary, that the fact of pictures by Leys and Edouard Frère being placed in the first line, or rather within reach of the eye—for the first row of pictures here touch the floor—was talked of for two good months." After enumerating a few of the works in the exhibition, the writer proceeds to say:—"One thing that struck me forcibly was, the decay of landscape and portrait painting. Landscape especially seems to be languishing in complete disfavour. It is nearly thirty years since a landscape painter was elected a member of the Royal Academy, and, judging by the hanging of landscapes, the committee feels nothing but contempt for them. As to portrait painting, how can English artists cultivate it with success? The life-sized drawing of the figure is not the object of special instruction as it is in France. There are no ateliers, and consequently no emulation. The academic courses include little more than the elements necessary for cabinet pictures; thus large canvasses are almost unknown in England, where artists confine themselves generally to a third the size of life. The removal of the Academy to Burlington-house, which, it is said, will take place shortly, is looked forward to with impatience; the exhibition will then have a less confined and more hospitable theatre, but when changing its mansion will the Academy abandon its littlenesses and its partizanship?"

Manufactures.

Flax Crop in the Netherlands. — The report of the Committee of the Netherlands Society for Promoting the Cultivation of Flax says:—"The committee at one time was in hopes of being able to give about the growing flax-crop equally as favourable a report as they could issue about all other outstanding crops. This hope has, however, been disappointed, as the excessive and continued drought during the months of May and June has proved prejudicial to the young plant, and to the late sown in particular. The breadth sown by our growers for their own account is hardly equal to that of last year; and, although a few landowners grew flax to sell in its green state, it may be concluded that the high price for corn, madder, and beetroot, has once more acted against the sowing of flax. The straw ripened sooner than last year, nevertheless it is not possible as yet to give a reliable report of the quality of the seed; at the same time it may fairly be expected that the well-grown flax will produce good seed, as the flowering season passed off regularly. In those districts which suffered from insects the result is doubtful. As to length, our new flax leaves much to be wished for, and as the reports from the various growing districts are not very satisfactory, it may be assumed that our this year's crop will not come up to an average one. In summing up, it appears to us that, with the exception of some parts, the early-sown flax, or say three-fourths of the quantity sown in our country, will produce an average crop, as it was strong enough to resist the continued and excessive drought. The prices paid for green flax range from £450 to £750 per bunder, being about equal to £15 or £25 per imperial acre. It will be some time before it can be ascertained whether the late rains have improved part of the late sown; the seed, at all events, has certainly been benefited by them. Pulling is now general, and being very early, the new flax will sooner than usual be ready for steeping."

Wages of Women in Paris.—The Chamber of Commerce of Paris have instituted an inquiry into the employment of females in that city, and the following are said to be results:—There are in Paris 106,310 ouvrières. They may be divided into four principal classes; those who earn from 3s. 9d. to 8s. per day, of whom there are 770; those who earn from 1s. 10d. to 2s. 6d. per day, of whom there are 39,000; those who earn 1s. 8d. a day, who are said to number 49,000; and, lastly, 17,000 who earn between 5d. and 1s. per diem. The average will thus be about 1s. 8d. per day, from which, however, deduction must be made for Sundays and fête days, and also for dead seasons, which amount, according to general calculation, to nearly a third of the whole year. The result arrived at is that, taking the whole year round, the average earning of a Parisian workwoman is about 11d. per diem.

Commerce.

Rolling Stock on the French Railways.—Th rolling stock of the six principal railway companies, who possess upwards of 13,000 kils. of railways in France, is composed of 110,400 vehicles (locomotives, carriages, waggons, &c.), and is as follows:—

Companies.	Locomotives.	Carriages.	Waggons.
Paris, Lyons, and Mediterranean	1,262	2,108	35,659
Chemin de fer du Nord	549	1,032	13,123
Chemin de fer de l'Est	762	1,962	16,316
Chemin de fer de l'Ouest ..	514	1,770	10,160
Chemin de fer d'Orleans....	690	1,945	12,299
Chemin de fer du Midi.	287	878	9,092

Silk Trade between France and Italy.—The following are the exports and imports of silk between France and Italy, for the first four months of the present year, as compared with those during the similar period in 1867:—

Exports to France.

	1868.		1867.
	Kils.	Frs.	Frs.
Grains (eggs)........	3,000	232,500	153,000
Cocoons	15,600	322,608	285,000
Raw silk............	51,200	3,456,000	2,953,200
Spun silk	288,900	27,445,500	23,235,800
Floss silk	379,800	6,972,175	3,362,500

Exports to Italy.

	1868.		1867.
	Kils.	Frs.	Frs.
Printed foulards	5.560	422,560	720,450
Plain stuffs..........	22,365	3,064,005	6,773,316
Worked stuffs	1,950	286.650	563.732
Mixed stuffs	6,750	567,000	1,151,970
Tulle	2,782	347,750	296,000
Trimmings, with gold	457	134.815	246,210
Ditto, in silk	542	73,170	115.290
Ditto, mixed	2,892	202,440	468,220
Ribbons	2,961	334,593	682,784

Correspondence.

Memorial Tablets.—Sir,—On looking at the last *Journal of the Society of Arts*, with which I am supplied as a member of the Society, I observed in p. 621, under the heading of "Memorial Tablets of Great Men and Events," one matter which, I think, needs some little correction. It is said that "Marquis Wellesley, soldier and statesman, lived and died in Listowel-house, Kensington, which stood upon the site of the present Ennis-

more-gardens." Having resided in this vicinity very nearly 57 years, *i.e.*, from my birth, I have, of course, considerable recollection of the locality, and I think the following is correct:—The Marquis lived and died in the Earl of Listowel's house (which I believe has been known as "Kingston-house") in the Kensington-road, in the parish of St. Margaret's, Westminster, and lying between Knightsbridge and Kensington-gore. This house is still standing, in front of Hyde-park, between Ennismore-gardens, on the one side, and Prince's-terrace and Prince's-gardens, in the Exhibition-road, on the other. Ennismore-gardens stands on the ground which was formerly attached to Lord Listowel's house, in which the Marquis Wellesley lived and died, and I suppose this may probably account for the little inaccuracy.—I am, &c., JOHN BLORE, architect.

223, Brompton-road, S.W., 20th July, 1868.

THE ELECTRIC TELEGRAPH POST BILL.—SIR,—Not one of the chief facts which were brought before the Society and the Chambers of Commerce in Union with it, in support of this Bill, was disproved before the select committee of the Commons. The leading principles propounded were recognised, and they have now been sanctioned by a full committee of the whole house, after hearing the objections raised by railway directors, and raised truly, that the whole measure went against what they called their industries, and the bill has been passed there. Looking at it as a precedent for future legislation, Mr. Leveson Gower, a director of the Bodmin railway, and a voter, on the railway commission, against interference with the companies, declared that its importance could not be over-rated. He was alarmed at the precedent it would set for the purchase of the Irish railways. He deprecated it as the inauguration of a new and large policy. Mr. Robert Phillips, another opponent, said that it should be brought before the constituencies at the hustings. Undoubtedly I concur in the suggestion, provided it be brought before them in a proper manner, and by parties who have no other than the public interests in view. I could not at first perceive the grounds of the opposition of some of the larger wholesale houses to the principles of a small parcel post, and of the cheap electric telegraph post; but I am informed, that whilst the measure would enable the retail dealers in country towns and rural places to save stocks, by telegraphing for articles as they want them, it would oblige the wholesale houses to keep more stocks, to go to additional expense for warehouse-room, and put them out of their present comfortable paces, without additional profit—that they can see. I hope their apprehensions, as to a fair remuneration, may not be well founded. But it marks a progress of opinion, that all the impassioned vaticinations of the representatives of the railway interests now failed to produce any impression on the house; they did not dare to provoke a division on the principle of the measure, and the great precedent has been deliberately sanctioned. The chief opposition raised to the measure was on financial points, on which I wish to make some observations. Mr. Göschen questioned Mr. Scudamore's estimates of the probable future of telegraphic returns. If, however, there were to be no improvement whatever in the use of the telegraph, it was demonstrated that the public or the Government was in reality giving three-and-a-half per cent. for a return of five; but all the evidence proves a steady advance of the telegraph receipts at the existing charges, set down, in the case of the International Company, at the rate of ten per cent. Unless it is to be assumed that the existing commercial depression is to be permanent, there is every reason to calculate upon the increase, even of that company's revenue, as progressive. With the increase at the rate of ten per cent., was Mr. Göschen's proposal equitable to base the compensation on a three years' average, instead of the net results progressively attained? He argued that future inventions would depreciate the value of the purchase. On the contrary, it is fair to anticipate that they will augment it. The tendency is to reduce the capital employed, or not to increase it, but to cheapen the working. To give one practical instance. If there be an increase of traffic along a line, the usual way of meeting it is to put down an additional wire, which costs ten pounds a mile and ten shillings per annum for maintenance. But by a new invention of Sir Charles Wheatstone's one wire may be made to do the work of six, at a cost one-fourth less than the cost of maintenance. The tendency of improvements must be to cheapen the work, or else why should they be adopted? and these improvements would always be available to the public. It is true that new companies might adopt them too, but it is a truth, not yet it would seem perceived, that any new company must have separate establishments, offices and staffs to pay for, and therefore cannot successfully compete with the government which has them paid for already. Mr. Gower preferred that the companies should by agreement try and do the work by an amicable arrangement with the post office;—an amicable arrangement to go on with separate establishments, in some cases three sets of establishments, from the same place to the same place! Mr. Göschen, in proof of the high price to be given for the works, cited the fact that the telegraphic works of France had cost only £900,000, and here we were going to pay several millions for telegraphic works. Just so, as I have previously stated; this is the penalty the public will have to pay for the commercial ignorance and incapacity of its representatives, in having permitted immense duplicate and triplicate expensive establishments to be constructed which the government of France with proper foresight prevented. The economic question is, in reality, less what the Government shall give, than how much it shall take out of the gains derivable from consolidation, and from the utilization of its own establishment, by taking up for the public the business of the trading companies. The International Company for one may justly say, "Whilst you (the Government) have hitherto been indolent and apathetic on the subject, we have worked up a good-paying and increasing business, with a large reserve fund; and now Mr. Göschen wants to take from us this business, yielding at present ten per cent., for sixteen years' purchase, at which, from anything in the market, we cannot replace our present income. He treats twenty years' purchase, or a selling value of 207, as being too high for this secure and improving income, which we do not want to sell;"—and the fact is there has been little of the stock in the market to sell. "But for how much less can we get even an unimproving income of the same amount. Will it be fair, by a practically compulsory sale, thus to augment your gains at our expense?" Mr. Childers proposed to refer the whole question of compensation to arbitration; but he must be young in public administration not to be aware how uniformly and heavily arbitrations are given against the public. In this very department the railway companies have got for the conveyance of mails double the price at which they were and are actually conveyed by coach. On the whole, looking at the practice in such cases, more would be lost than could be gained by delay. Besides one important point of administrative principle, to which I shall beg to draw distinct attention, for its practical application, I repeat, we have now a legislative sanction to the precedent for railway reform, *i.e.*, of the principle of unity of management, under public responsibility, of the means of intercommunication, and for sharing the gains thence derivable between the public and the shareholder. In railway administration it is to be borne in mind that the proved gains derivable are upwards of twenty per cent. on the net income. Shall not that gain be achieved for the shareholders as well as for the public? The government may there get five per cent. for three and a-half. Shall it not be got as in the case of the telegraphs? The early consideration of the sequestions, in the first instance for Ireland, is opened by the great electric telegraph measure.—I am, &c., EDWIN CHADWICK.

PARLIAMENTARY REPORTS.

SESSIONAL PRINTED PAPERS.

Par. Numb. *Delivered on 11th July, 1868.*

151. Bill—Titles to Land Consolidation (Scotland) (amended).
211. ,, Municipal Elections (Scotland) (amended).
213. ,, Registration (Ireland).
220. ,, Liquidation.
224. ,, Tain Provisional Order Confirmation.
257. (I) Customs (Landing Department)—Minutes, &c.
340. Coinage—Account.
357. Poor Rate (Scotland)—Return.
377. Ordnance—Report.
386 Army (Prize Money)—Account.

Trades Unions and other Associations—Ninth Report.
Public Petitions—Thirtieth Report.

Delivered on 13th July, 1868.

226. Bill—General Police and Improvement (Scotland) Act Amendment (amended).
227. ,, Danube Works Loan.
229. ,, Drainage and Improvement of Lands (Ireland) Supplemental (No. 3).
98. (IV.) Civil Services Estimates—Corrected Pages.
366. Military Savings Banks—Account.
383. Friendly Societies (Scotland)—Report.
405 Railways (Ireland)—Return.

Public Health—Tenth Report of the Medical Officer of the Privy Council.

Delivered on 14th July, 1868.

363. Education (Ireland)—Return.
365. Cape of Good Hope Mails—Correspondence and Contract.
389. Merchant Shipping—Account.
404. Curragh of Kildare Bill—Report.
419. Civil Services - Supplementary Estimate.

Delivered on 15th July, 1868.

228. Bill—St. Mary Somerset's Church, London.
230. ,, Sir Robert Napier's Annuity
231. ,, Poor Law Board Provisional Order Confirmation.
234. ,, Admiralty Suits.
370. Burials in Churchyards (Ireland)—Return.
373. (I). War Office (Control Department) Further Correspondence.
385. Chamber of London—Annual Accounts.
394. Navy Estimates—Memoranda.

SESSION 1867.

500. East India (European and Native Troops)—Return.

Delivered on 16th July, 1868.

232. Bill—Compulsory Church Rates Abolition (as amended by the Lords).
233. ,, Artisans' and Labourers' Dwellings (as amended by the Lords).
235. ,, Drainage and Improvement of Lands (Ireland) Supplemental (No. 4).
236. ,, Colonial Shipping.
392. Grand Jury Presentments (Ireland)—Report.
396. Army (Non-purchase Corps)—Instructions.
422 Marriages (South Australia)—Act, &c.
428. War Office (Audit Department)—Letter.

Manufactures, Commerce, &c —Reports from Her Majesty's Secretaries of Embassy and Legation (No. 4, 1868).
Colonial Possessions—Statistical Abstract (1852 to 1866)—Fourth Number.

Delivered on 17th July, 1868.

237. Bill—Railway Companies.
238. ,, Sale of Poisons and Pharmacy Act Amendment (amended).
379. Ecclesiastical Commission (Ireland)—Annual Report.
354 Bank Holidays Bill—Report and Evidence.
410. Abyssinian Expedition—Return.
415. East India Irrigation Company—Return.

Technical and Primary Education—Circulars, together with their replies.

Delivered on 18th July, 1868.

239. Bill—Electric Telegraphs (amended by the Select Committee).
240. ,, Hudson's Bay Company.
241 ,, Expiring Laws Continuance.
242. ,, Woods and Game Assessment.
351 Superior Courts of Common Law, &c.—Return.
401. Special and Common Juries—Report of the Select Committee.
409. Kitchen and Refreshment Rooms (House of Commons)—Report from Select Committee.
414. Penang Mails—Correspondence.
435. Electric Telegraphs Bill—Special Report.

Foreign Statistics Part XI Statistical Tables.
Public Petitions—Thirty-first Report.

Patents.

From Commissioners of Patents' Journal, July 17.

GRANTS OF PROVISIONAL PROTECTION.

Ammonia, extrication and condensation of—2067—I. Baggs and F. Braby.
Billiards, &c., marking board for—2114—F. A. Pavey.
Boilers—1942—T. H. P. Dennis.
Boilers—2075—J. Morris.
Boilers—2080—J. Wardman and J. and F. Baldwin.
Boilers—2091—G. Bower.
Boilers, furnaces, &c. 2089—F. J. Drechsler.
Bottles, manufacturing—779—W. Langwell and H. Spring.
Brick-making machinery—2073—H. Large.
Cartridges—1834—R. Woinar.
Engines and pumps—1334 C. B. and J. Hardick.
Engines, &c., replacing on the line of rails—2069—J. Bowker and J. Ivers.
Fabrics, &c., bleaching—2085—C. E. Brooman.
Fabrics, &c., drying—2081—W. Baxter, D Waring, & J. S. Wooller.
Fire-arms, &c, breech-loading—2077—W. C. Stiff.
Fire-arms, &c., breech-loading—2096—A. M. Clark.
Flax, &c., preparing—2120—A. M. Clark.
Fuel economizer and feed-water heater—2138—R. Needham.
Iron and steel—1696—J. J. Harrop and W. Corbett.
Liquid and gas meters—2132 J. A. Muller.
Liquid meters—2084—A. V. Newton.
Locomotive engines—2128—J. and G. M. Ward.
Looms—2082—R. Shaw and J. Clayton.
Manure, spreading—1863—S. Wilkerson.
Metal castings—1849—A. Prince.
Metals, smelting, by the use of hydrocarbonaceous fluids and superheated steam—2065—P. R. Hodge.
Motive-power—1878—J. Bourne.
Naphtha, burning the vapour of—2088—W. R. Lake.
Naphtha, &c., apparatus for the combustion of—2090—G. Glover.
Paper pulp, manufacturing—2126—J. H. Johnson.
Parkesine, treating—741—J. Lewthwaite.
Printing materials—2108—L. Francis.
Railway breaks—2102—W. Brookes.
Saccharine and saline solutions, treating—2134—A. Fryer.
Saltpetre, &c., manufacturing—2112—J. E. Poynter and T. L. Patterson.
Sewing machines, stands for—2093—J. Blomfield.
Shawls, &c—2087—C. E. Brooman.
Ships' signals, &c.—1768—F. N. Gisborne.
Shoes for horses, &c.—2122—J. H Johnson.
Tape measures, &c., cases for holding and winding—2074—G. H Wilson.
Thrashing machines—2118—D. Fender.
Thread-polishing machines—2071—G. McCulloch.
Tickets, numbering and printing consecutively—2094—M. Bebro, O. Hopwood, and W. Elam.
Tobacco, twisting—2100—T. Ward and W. S. Black.
Toys, automaton—2130—W. E. Newton.
Velocipedes or vessels, marine—1990—A. J. B. P. Thierry.
Watches, &c.—2086—G. H. Wilson.
Warps, &c., sizing and drying—1306—J. H. Bolton.
Winches and cranes—2035—S. Owens and T. Patterson.

INVENTION WITH COMPLETE SPECIFICATION FILED.

Railway carriages—2211—W. R. Lake.

PATENTS SEALED.

176. E. Dorsett.	465. A. Brin.
212. W. J. Coleman.	494. W. R. Lake.
216. W. Davis.	609. J. Macintosh and W. Boggett.
251. W. J. Jennings.	1276. T. A. Warrington.
280. W. E. Newton.	1343. C. Brown.
284. J. Roberts and J. Morgan.	1552. S. B. Boulton.
367. W. R Lake.	1613. W. Allday.
394. W E. Newton.	1622. W. Manwaring.
444. W. B. Adams.	

From Commissioners of Patents' Journal, July 21.

PATENTS SEALED.

21. A. Cox.	303. W. H. Richardson and W. Beardmore.
70. M. Walker & G. H. Money.	352. H. Aitken.
228. S. Bennett.	356. J. Jameson.
235. T. Cook.	383. P. Graham.
238. D. Y. Stewart.	391. F. Ardache.
239. H Hodge.	439. W. B. Marston.
240 G. Kirk and W. Murray.	441. N. C Szerelmey.
241. J. C. Sanders.	459. C. and L Verhulst.
246. G Allibon and A. Manbré.	481. J. G. Willans.
252. J. and D Storer.	515. L. Mummenhoff.
254. E. W. De Rusett and R. F. Dale.	537. J. and J. Thompson.
258. K. J. Winslow.	557. J. G. Jones.
263. C Kilburn.	587. W. Wilson.
265. C. Ritchie.	965. H. Bessemer.
268. E J. W. Parnacott.	967. H. Bessemer.
270. A McDougall.	1058. J. G. Jones.
288. H A. Bonneville.	1095. H Bessemer.
289. W. A. Gibbs.	1365. A. Clark.
301. J. H. Johnson.	1482. C. J. Chubb.
302. J. D. Brunton.	1511. H. N. Penrice.
346. J. Frame.	1559. J. W. Chamberlain.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

1894. W. La Penotière.	1881. W. Tranter.
2128. N. C. Szerelmey.	1893. R. C. Bristol.
1882. D. Caddick.	2152. J. Bowden.

PATENTS ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.

1777. B Browne.	1825. J. H. Johnson.
1821. W. and P. H. Savory.	1818. P. Shaw.